Engineering
Library

February 3, 1921

FEB 7 1921

# Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

## *Road-Building Issue*

**Road Construction in the Cypress Bottoms of Arkansas**
By Don A. MacCrea

**Highway Bridge Conditions and Requirements—A Symposium**

**Practical Effects of Motor Operation Costs on Highway Location and Grade Design**
By W. G. Harger

**Subgrade Support in Pavement Design**
By Clifford Older

**District Maintenance Engineer's Report Blank**

Paving Bronx River Parkway Drive With Asphalt Block, Near White Plains, N. Y.

# KREOLITE LUG WOOD BLOCKS

"Outlast the Bridge"

## Typical Kreolite Bridge Floor

Kreolite Lug Wood Blocks, Kreolite Tongue and Grooved Planking, Kreolite Felt, Kreolite Bituminous Filler and Kreolite Bituminous Koating made this an absolutely water and wear proof floor.

The above bridge, at Plymouth, Pa., is 1257 feet long with a roadway 18 feet wide.

The old wearing surface with a reinforced-concrete foundation failed after nine years of service.

Write for our guaranteed Kreolite Lug Wood Block Bridge Floor Specifications—Just out!

**The Jennison-Wright Co.**
**79 Kreolite Bldg., Toledo, Ohio**

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

# ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

Volume 86 — NEW YORK, THURSDAY, FEBRUARY 3, 1921 — Number 5

## Protecting the Hudson Channel

SECRETARY OF WAR BAKER has done well in refusing New York City's plea to make permanent its temporary extension of piers into the Hudson. The conclusion is unavoidable that the city has never been honest in its dealing with the Government in this matter of channel encroachment, but has consistently pursued a policy of getting the camel's nose under the tent. These gradual grabbings of a bit more of the Hudson River are merely an avoidance of a real port policy and intentionally disregard the rights of New Jersey in the river and port. Possibly now the city will consider more seriously the limitations of the lower Hudson front and begin to think of the port as a whole.

## The Good Roads Congress

AS A forerunner to the Good Roads Congress which will open in Chicago next week under the auspices of the American Road Builders Association this number of *Engineering News-Record* has been made a "Road Building Issue." It contains a number of articles dealing with the work of design, construction and maintenance which engineers and contractors in various parts of the country are doing. This year promises to be an important one in the road-building field. Lower prices of materials and labor and the improbability of factors such as the car shortage which held up work last year offer substantial grounds for an optimistic outlook. It is important, therefore, that the road congress shall have a large and representative attendance. To engineer and contractor is offered the opportunity of keeping abreast of the best thought in highway subjects and of learning what the manufacturers are doing in supplying new or improved types of road-building equipment.

## Hog Island Closes

IN THE depth of winter just three years ago, violent controversy broke out over a new enterprise of titanic magnitude, the building of a great shipyard on a marshy island in the Delaware River and the name of Hog Island became famous—or infamous—over night. Men had undertaken the impossible down there. Through ice and snow they struggled against hopeless odds to convert a bold conception into a reality. Railway, labor, and organization difficulties seemed insuperable. Yet only a few months later Hog Island was putting ships into the water, and had fairly started on its career as the greatest shipbuilding machine ever created. That career has now reached its end, for this week Hog Island closes its gates. Its work is done; the "Aisne," last of 122 ships, made her trial trip a week ago, and henceforth the name of the great yard will be only a memory of heroic achievement. It will be remembered particularly in connection with our profession, for it was civil engineers who created Hog Island. Leaving their accustomed activities they set themselves a new task and entered upon its execution with faith and courage. All about them was the cry that ships must be built in vast numbers, and they undertook to answer that cry. The greatest part of their task was performed through Hog Island. Much has been written of the dreams that were made real on that mile of marsh. The designing of ships for factory production, the building of hull sections by the hundred thousand tons in many scores of bridge shops scattered over a dozen states, the rapid and systematic assembling of these sections on fifty launching ways, the creation of great plants for fitting out and equipping ships, all have been made the theme of inspiring story. There is no need to rehearse the facts here. But in these closing days of the enterprise it is fitting to recall that in all of its stages the achievement at Hog Island is a monument which our own profession has erected to itself. The names of the field leaders of the work will always be remembered—the names of Robinson, of Goodenough, of Muhlfeld, Wood, Holbrook and Brush, men who vitalized the work with inspiration and guiding thought. But the names of a host of other engineers stand alongside these. The record is one of pride and honor to each member of the host.

## Foundation Failures

BRIDGE history is thickly dotted with foundation failures, and the remarkable case of the Third St. bridge in Dayton is thus only an addition to the long account. Most failures, in fact, originate in the foundation, and this is peculiarly true of bridges. In the case of a wall, a failure—a yielding of the subsoil—may be merely annoying or disfiguring, but it is likely to lead on to ruin in the case of a bridge. The current record is distinctly bad. As even a cursory reading of the news will show, every freshet takes its toll of bridges; and with very rare exceptions the foundations are responsible. Great floods, like the Central States flood of 1913, exhibit the situation most impressively, but their teaching is perhaps least convincing. One is tempted to reason that it will not pay to sink the piers of every bridge throughout the country to a depth safe beyond all imaginable scour, merely to guard against the loss of a dozen or two in the great emergencies that may occur but once in fifty years. But there is a direct lesson in the losses in ordinary freshets: They constitute an indictment of our foundation practice, for it is the engineer's business to provide for all normal contingencies. The record of failures suggests that we do not regularly apply the same prudence and conservatism of technical judgment to the foundation as to the superstructure. Is this chargeable to the fact that we have no scientific knowledge of foundation problems, or is it due to a willingness to take chances with construction that is hidden below the ground? Correction of the existing situation depends on how this question is answered.

## Problems of the County Highway Engineer

AS AN indication of the trend of thought of county highway engineers, the annual meeting last week of the New Jersey State Association of County Engineers, reported in the news section, deserves consideration. Each state, of course, has its own problems and without a thorough-going canvass there would be no grounds for asserting that the kind of thinking which Jersey's county engineers are doing is typical of that in other parts of the country. Nevertheless, the meeting emphasized several phases of the local highway administrator's work which are of first importance at the present time.

One clear inference from the Jersey meeting is the need for a number of amendments to state and county road laws. A score or more of proposed changes were offered. The county engineers recognize that the best interests of all concerned are furthered by meeting the contractor half way. As evidence of this feeling only one or two instances need be cited—the proposal to pay contractors 80 per cent of the value of road materials delivered at the site of the work; to retain not more than 10 per cent of the value of work in place, instead of 20 per cent as at present; and to accept completed work in units of one mile with provision for paying for each unit in full when completed and accepted. Obviously if such amendments are incorporated into the state's road laws the contractors' position will be vastly improved. Money has been tight and contractors are not now able to finance their work by borrowing at the low rates of interest prevalent in pre-war times. Any revision of the clauses in public works contracts which provide a more liberal policy of paying for work done without removing safeguards for honest, efficient work, is a step forward.

Transportation, as distinguished from the narrower field of merely building roads, is another of the subjects to which engineers, as evidenced by the New Jersey meeting, are devoting a great deal of thought. It is realized with fuller appreciation every year that the planning of extensions to state and county highway systems is a matter for the present—not for some indefinite future period. Attention is being given to putting the proper types of highway in the proper places, linking up important centers of manufacture or commerce, and providing routes so co-ordinated as best to serve the interests not only of state but of interstate traffic. The problem involves, also, a knowledge of traffic requirements, the protection of the vast capital investment in durable pavements by restricting the weight and size of vehicles and, what is of particular importance, the provision of means for enforcing such regulations as are placed upon the statute books. In New Jersey at present the maximum allowable weight for a vehicle is 30,000 lb. and it is worth noting that the State Highway Commission and the Motor Vehicle Department are to co-operate in enforcing this limitation by means of road scales, five of which, each with a capacity of 50,000 lb., are now being installed. It is only by such means that "teeth" can be put into any legislation designed to protect public highways from damage by vehicles carrying unreasonable loads.

Opinion on the traffic situation in Jersey was crystallized in a committee report which recommended a wider extension of traffic census and research work. The need for standardization of traffic census operations is recognized and the committee believes that advance planning of the highway system should look ahead twenty years so as to provide routes of ample widths and durability for future transportation needs.

## The Associated General Contractors

PREVIOUS to the organization of the Associated General Contractors, to repeat a thought expressed in these columns two weeks ago, there were no contractors' meetings comparable in importance to those of the American Society of Civil Engineers. We also expressed then the belief that such meetings had now been made possible by the new association. Last week's convention of the contractors at New Orleans completely vindicated that faith. In fact, in virility and vision the promise is that the contractors will set a pace for their engineering associates.

The great outstanding accomplishment of the convention was the endorsement of the broad plans developed by the executive board during the past year. There were those who came to the convention half in the belief that the association was leaping before it had learned to run. With the progress of the convention the doubts disappeared, a settled conviction developed that the plans were none too big and that every activity had a sound basis and was intelligently planned and directed. At the last session the broad program received unanimous endorsement, through the approval of the year's budget. This action sets the seal on the association's future. With a remarkably competent leadership, and the present backing of 750 of the strongest contracting companies in the country, the association can be counted among the permanent and effective forces in service. One could not for three days listen to discussions in meetings and in corridors without learning that this was a work-a-day standard by which all the activities were to be tested.

Nor was there any wishy-washy sentimentality in the expression of the idea. It was mentioned as a matter of course, as one of settled conviction. Contractors are expected to be forceful personalities. They are—and they were at New Orleans. They did not mince words regarding their views. Although they hit hard when they thought hard hitting was called for, they gave evidence that they do not expect to "bull things through," but to secure acceptance of their positions by demonstration of their reasonableness. Out of that attitude came a second dominant note of the convention—that the best results for the public are to be accomplished not by the contractors playing a lone hand but by co-operating, where pertinent, with other branches of the construction industry.

A striking fact brought home by the convention—and it was repeatedly referred to on the floor—was that the personnel of the contracting business has undergone a radical change. The "rough-neck" contractor is passing, or has passed—never to return. Instead there is a keen, cleancut business man, adopting all the methods of modern business organization. This fact must be fully appreciated in order to understand the spirit of the A. G. C. and to have faith in the future.

To date the accomplishments are remarkable—again due to the business man in contracting. With standards pitched high, with energy, with vision, the work ahead will be of immense value to the construction industry and to the public. The convention just closed marked a great step forward in the construction world.

## Handling Freight at New York

FULL consideration of the report of the New York-New Jersey Port and Harbor Development Commission must await the issuance of all of the detailed chapters summarized in the report made public last week.

The summary of the report indicates how completely the commission has made its study. It promises a wealth of material when all the data are published. For the first time the conditions in this port have been thoroughly analyzed and prospective development laid out on actual figures and not on assumed conditions. Generalities as to existing freight movements and prophecies which feature most of the previous port solutions are supplanted here by facts obtained at large expense. It is testimony to the good sense of those engineers who have worked on the problem in the past that even after all of the time and labor expended by the commission on this study, the report, so far as the summary discloses, reveals only one radical divergence from schemes that have been proposed in the past, and even this one resembles in a number of ways the suggestion made twelve years ago. The virtue of the report lies in selecting the best of the previous proposals for port improvement and in putting upon this consolidated selection the seal of approval backed up by two years of thorough technical investigation.

The commission endorses the railhead port idea. This necessarily involves belt line railways in New Jersey and Brooklyn and the consolidation and reduction of lighterage and railway pier stations in Manhattan. The plan further comprises a reform of the food marketing system of the district, the desirability of wider piers and of judicially selected handling machinery, the dredging of channels, and several such minor improvements. None of these is new, though the portions of the report not yet published may reveal some novel details. Especially interesting to those in the port outside of Manhattan Island will be the specific recommendations for the development of the outlying areas—Newark, Jamaica and the Upper bays for instance. The West Side Manhattan situation, emphasized so strongly by the commission, may be the root of the whole port problem, but the commission must recognize that the benefits accruing from its solution, while spreading over the whole port, do not spread equably, and that many in the district will have to see direct benefits to their own locality before they will approve the joint port idea.

The outstanding if not spectacular feature of the scheme is the so-called automatic electric railway loop to take care of Manhattan freight. By this arrangement Manhattan-bound freight would enter the Jersey yard in main-line freight cars and be classified on trailers and trucks which would be run into special standard-gage tunnel cars made up and directed in trains to specific terminals. When reaching the terminal the cars are lifted on an elevator to the drayage floor, the trailer trucks run out, and the contents either loaded on motor trucks or moved directly to the warehouse which would form the upper story of the terminal. Westbound freight would then be loaded on the cars and the train moved—always in the same direction—back to the classification yard.

So far this scheme has all of the characteristics of the solution proposed by Col. W. J. Wilgus in 1908 (*Engineering News*, Oct. 15, 1908, p. 403). The new features now submitted are a deep tunnel which would afford cheaper construction, the use of a super-standard car instead of a 10-ton tunnel car and above all the adoption of the automatic electric control whereby the tunnel trains move around the loop without motormen or riders. The commission holds that this automatic control is a vital part of the scheme, because only by the close spacing and uniform speed that such control assures can the necessary capacity be achieved, or at least that to get equal capacity on a man-operated system would require much more trackage and equipment at increased cost. Furthermore, it holds that the capitalized operating cost of the manual system far outweighs the first cost of the automatic control.

So elaborate an extension of the automatic control idea is far beyond any present engineering experience. It is simply one of those things that have never been done. That, however, need not condemn it, and the engineers of the commission not only are willing to stake their reputation on its succeeding but have the approval of a number of the experts of the electrical manufacturing companies to back them up. On the other hand, the published chapters of the report of the commission are singularly lacking in a comparison of the loop-elevator-special-car scheme for manual operation and in shallow tunnels with their favored solution. They analyze and reject two standard-car west side railways, one elevated and one in subway, in neither of which are included the feaures which contribute most to the "automatic" scheme, namely, the breaking of bulk in New Jersey, with the demountable body or trailer-truck loading in loop tunnel cars to Manhattan. It would seem incumbent on the commission to make as complete an analysis of the Wilgus scheme—with such amendments as twelve years advance suggest—as they have of their three schemes. Relative advantages and costs of the shallow and deep tunnel would be particularly interesting.

Unquestionably the commission is right in its contention that standard freight cars can no longer be profitably brought onto lower Manhattan Island. Bulk must be broken, and preferably sorted, somewhere on the mainland and the city freight brought in as nearly as possible in carriers which permit of mass distribution to the consignee. The new plan definitely promises a relief from the intolerable truck congestion around the pier stations and distributes the total motor truck traffic in the streets. In so far as ocean transshipment in Manhattan is concerned, the deep subway offers no improvement except perhaps in shorter truck hauls, if indeed it is intended that any freight between the ocean liners and rail haul is to be carried except by lighters. In other words, the subway and its terminals are mostly a solution of the problem of handling freight produced and consumed on the Island. It offers no relief for the handling of fuel or of passengers from the west.

These are merely the high spots of comment on the report. The important thing now is that the commission has all but completed its allotted task and has prepared an analysis of port development the like of which has never been seen. As it truly says, most of its labor will be in vain if the co-ordination of the port district is not in some way brought about so that the comprehensive plan—subject to such detail changes as further study and conference may develop—may be put under way. The immediate future is now in the hands of the state legislatures. Too great postponement of action will only bring about Federal intervention.

# Road Construction in the Cypress Bottoms of Arkansas

## Soils Rendered Unstable by Frequent Rainfall—Clearing and Grubbing Necessary—Backwater Overflow Frequently a Problem

By Don A. MacCrea
Ford & MacCrea, Consulting Engineers, Little Rock, Ark.

*Highway construction in the cypress bottom lands of the southern Mississippi River and its tributary streams is largely an operation in virgin territory. This description of the construction of the Arkansas-Louisiana Highway in southeastern Arkansas typifies both the conditions confronting the contractor and the means found most successful in meeting these conditions. The outstanding facts are:*

*(1) Clearing and grubbing is a construction task of magnitude.*

*(2) In undrained, unleveed bottom, overflow is a probable construction risk.*

*(3) Rainfall frequency is of extreme importance because the prevailing soils are easily affected by moisture and are slow to give up their water content.*

*(4) Heavy wheeled equipment, as graders and motor trucks, are impracticable because the soils are made unstable by frequent rains.*

*(5) Teams and scrapers are the most efficient grading equipment.*

*(6) Sand sub-base has proved its worth on clay and "buckshot" subsoils.*

*(7) Dry batch haulage to paving mixers by industrial railway best meets subgrade conditions in laying concrete base. Truck haulage of wet concrete from central plants is impracticable.*

*(8) In hauling bituminous surface material, heavy trucks give larger daily yardages, but light trucks give a better average progress for long periods.*

*(9) Flat topography and slow run-off make the drainage problem difficult.*

*(10) Probable future reclamation by drainage, counsels the construction of temporary bridges until stream changes and ditch locations are determined.*

*(11) Long mileage contracts involve risks which the state should share with the contractor.*

*(12) Construction camps will reduce labor turnover and loss of time.*

*(13) An engineering-construction organization based on railway practice best meets the requirements.*

PAVED road construction in the Mississippi bottom lands, as exemplified by the Arkansas-Louisiana highway, presents unique characteristics. The natural conditions, as soil, weather, overflow and forest, necessitate special equipment and methods. Methods of organizing and financing the improvement place restrictions on freedom of engineering design and location and of contract practice. All of these factors appear in the operation named because of its great length of 153.67 miles in five counties, which also requires enough contractors to give variety of practice in planning construction outfits and ways of conducting work.

Except 11.87 miles of 7-in. trap rock macadam in Lincoln County and 28.57 miles of 7-in. bank gravel macadam in Ashley County, Fig. 1, the Arkansas-Louisiana highway is 2-in. Topeka mix on a 5-in. concrete base. On the sharper curves the road is widened to 16 and 18 ft., but elsewhere it is 14 ft. wide. This width is out to out of 6 x 7-in. curbs on the 113.18 miles of paved road. Both macadam and hard pavement are placed on a grade 22 ft. wide with side slopes of 1 on 1½, 1 on 2 and 1 on 3 according to the height of the fill. The 4-ft. shoulders are planted with Bermuda sod to hold them against wash. The width of right of way varies from 50 to 70 ft., except through towns, but in some places in only 40 ft., which has been found to be rather narrow even for very low embankment.

Concrete base design received special attention. Generally a 5-in. base of 1-3-6 concrete was employed. When the subgrade was particularly soft, the base was thickened slightly and a 4 to 7 in. sand sub-base was placed on the clay or gumbo grade. This sub-base was also employed on the macadam sections. Experience indicates this sand treatment of the clay and gumbo to be valuable. A pure sand was not used in all cases; soils containing a high percentage of sand were found satisfactory. Had not limitations of cost prevented, a greater thickness of base on bad subgrade would have been better engineering. A 2-ft., gravel macadam shoulder on each side would also be an improvement worth while even now, since it would provide an 18-ft. roadway at little additional cost and would reduce shoulder maintenance.

Much thought and study were given to the problem of expansion and contraction of the concrete base, and several experiments in controlling these actions were undertaken. In the beginning, some mileage was laid leaving a joint in the base at the end of each day's run and filling this joint when the asphalt top was placed. The result was a puffing of the asphalt over each joint in hot weather. On the sections without joints there was experienced last summer some slight buckling due to expansion; these "explosions" averaged about one every mile. In no case were expensive repairs necessary. When broken stone aggregate was employed there was less trouble from expansion than when the aggregate was gravel.

Summarized, the various types of construction and their volumes were:

| | | | |
|---|---|---|---|
| Clearing, acres | 351 | Conc. base, sq.yd. | 852,500 |
| Grubb'ng, acres | 370 | Asph. top, sq.yd. | 852,500 |
| Embank. exc. cu.yd. | 690,000 | I-beams, lb. | 76,000 |
| Class A conc. cu.yd. | 4,950 | Piling, lin.ft. | 17,600 |
| Found. Exc. cu.yd. | 7,430 | Grav. macadam sq.yd. | 234,800 |
| Reinf. Steel, lb. | 194,000 | Stone macadam, sq.yd. | 97,700 |

In this summary the quantities of clearing, grubbing and embankment are to be especially noted.

As shown by Fig. 1, the location is in the alluvial plain bordering the Mississippi River. Much of this area, previous to the leveeing of the Mississippi and Arkansas rivers, was subject to overflow. The topography is exceedingly flat and the rainfall run-off is correspondingly slow making the drainage of a highway very difficult.

Arkansas legislative restriction on engineering location were well typfied in the selection of the route. This route, by the act authorizing the improvement, was fixed for the most part on existing roads which in some cases were little more than trails. Therefore where changes of location were considered advisable, it was necessary under the state laws to secure the approval of the County Court before the changes could be made as it was also necessary so to secure right of way, this court in each county, having original jurisdiction over highway location and right of way. In many cases, where changes of alignment were recommended, approval was secured, but in a few cases local politics and local interests prevented the change being made.

As a result excess mileage and curvature appear in some instances where they could and should have been avoided. Also grade crossings were not eliminated where they might have been. Comparatively however, this condition has been much improved, fully 50 per cent of the old crossings having been eliminated and those existing having been confined within towns, near the stations where reduced speed can be expected.

Generally the location follows the tracks of the Missouri Pacific Ry., which gave good track facilities. Approximately 70 per cent of the route required clearing and grubbing and approximately 50 per cent is on clay and gumbo soils. This last fact has importance in connection with rainfall.

Normally Arkansas has 50 to 60 in. average annual rainfall. This average has been exceeded during the last two years as shown by the charts of Fig. 2. The more important indication of these charts is, however, the frequency of rainfall. This was the greater handicap to construction because the clay and buckshot soils become unstable with little moisture and recover very slowly from even light rainfall.

## Construction Methods

Considering the operation as a whole, construction was begun and progress, to the end of 1920, was maintained as shown by the diagram Fig. 3. This diagram indicates also the main classes of work.

Long hauls generally were required for all materials. Broken stone for the Lincoln county macadam section required an average rail haul of 72 miles and gravel for the Ashley County section an average haul of 150 miles. Chats from the Missouri zinc mines for mixture with asphalt for the top, were hauled 350 miles. Sand and gravel for the concrete base was secured by the Arkansas Gravel Co., at Arkansas City. Here the material is pumped from the river, proportioned by screening and shipped as proportioned. As good concrete has been obtained with the porportioned aggregate as when the sand and gravel are mixed separately.

Heavy grading equipment proved impracticable. Several types of large and small blade graders, tractors and elevating graders were tried out very thoroughly but had to be abandoned because of the soil made unstable by frequent rains. About 90 per cent of the grading has been performed with teams, wheel and slip scrapers and Fresno scrapers and in some sections which have been particularly wet it has been necessary to place embankment by station men. Clearing and grubbing was a preliminary to practically all grading, as indicated by Fig. 4. These, as indicated by Fig. 3, were pushed the first year, so as to have the grading completed far enough ahead of the paving to ensure settled fills. In only a few instances has it been necessary to lay pavement on any fill of more than 2 ft. which was less than a year old.

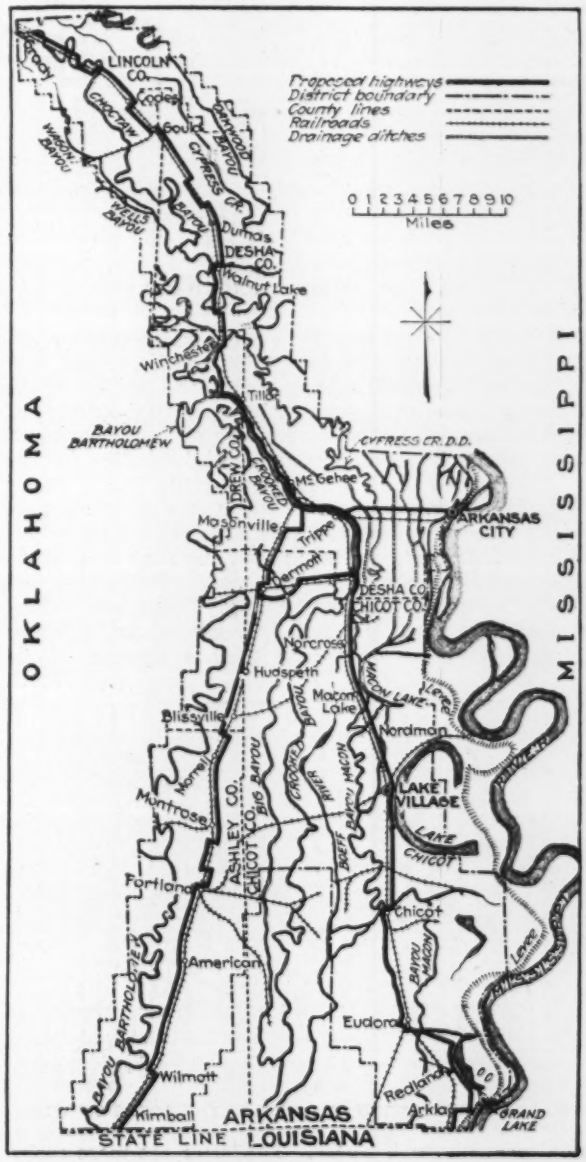



FIG. 1. LOCATION MAP OF 154-MILE ARKANSAS-LOUISIANA HIGHWAY

In constructing concrete base, the contractors are successfully using, for handling aggregate, unloading cranes and industrial railways, with steel cars and gasoline locomotives. The most successful arangements are those by which a removable car body or batch boxes are handled by a mixer crane. The dumping of sand and gravel on the subgrade by either cars or trucks and conveying them to the mixer have been abandoned. Wood ties for industrial track have been tried, but it has been found that sectional steel track has many advantages, especially if the steel ties have sufficient bearing area to carry the track on soft subgrade. Several types and weights of gasoline locomotives are being used, but experience has shown that they should be just as light as the grades will permit. With industrial railway haulage, maximum runs of 1,500 sq.yd. of

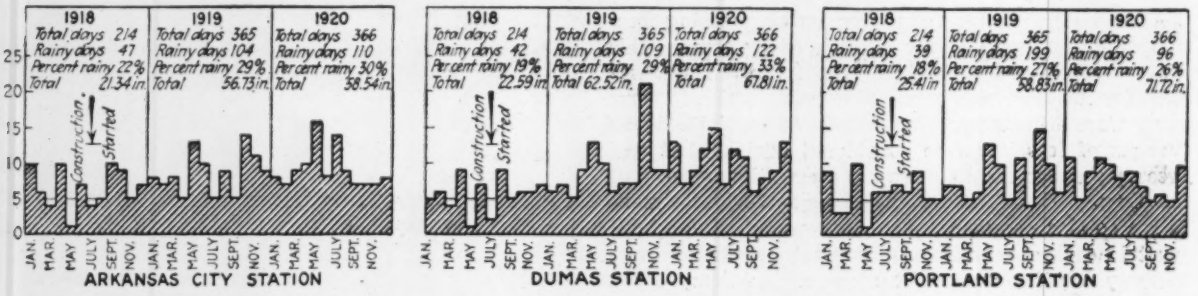



FIG. 2. DAYS ON WHICH THERE WAS MORE THAN ONE-HUNDREDTH INCH OF RAIN AT THREE OBSERVATION STATIONS

5-in. base per day have been made and one plant has averaged between 1,000 and 1,200 sq.yd. per day.

The use of central mixing plants, the hauling of the mixed concrete in 3½-ton trucks, and truck haulage of sand and gravel to the mixer, have all been abandoned after thorough trials of many months' duration for the reason that the character of the subgrade, Fig. 5, makes it impossible to use trucks except in very dry weather.

For placing asphalt top, standard railroad type portable asphalt plants are being used and runs of 1,500 to 2,200 sq.yd. per day have been made. Both large and small trucks are used for hauling. The use of heavy trucks gives much larger daily yardages, but a better average progress over long periods appears to be

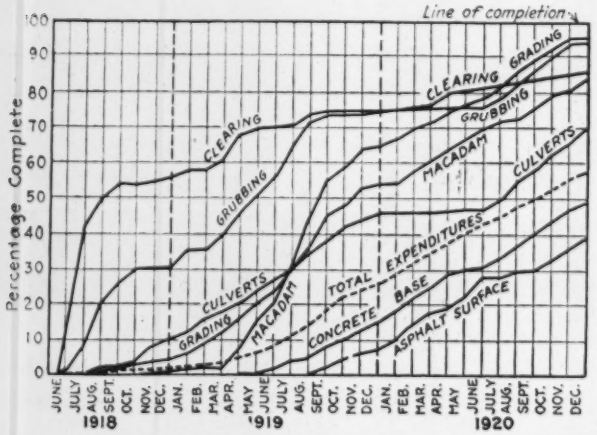



FIG. 3. CONSTRUCTION PROGRESS BY CLASSES OF WORK

obtained with small trucks. The latter are more easily handled and turned on light turntables pulled along just in advance of the rakers. Much time is lost in turning the heavy trucks on the narrow roadway. Generally the asphalt plant sites are kept three to five miles behind the base concreting so as always to have concrete base on which to haul the asphalt.

In addition to the usual difficulties of construction, there was added during the months of May and June of 1920, for a period of 60 days, the flooding by back water from the Mississippi River of the roadbed and right-of-way from a point near the town of Halley to the town of Chicot in Chicot County, and from a point near Trippe east to Arkansas City in Desha County. This flooding, Fig. 6, was caused by a gap left in the levee system, providing an outlet for Cypress Creek, which could not be closed until the contruction of the drainage system in Desha County had reached a point where these waters could be diverted south. It was planned that this gap would be closed in the year 1919, but due to excessive rainfall the contractors failed to complete the work. This permitted the waters from the Mississippi to flow into the basin after reaching an elevation on the gage which had not before been reached in the past seven years. Some of the embankment was covered with water to a depth of from 2 to 4 ft. However, the erosion loss was exceedingly slight and the tie-up and loss of time which occurred to the contractors' operations in laying pavement was the most serious feature. This gap in the levee system has now been closed and the highway should be free from further flooding unless exposed to an actual break in the levee system.

Reinforced-concrete box culverts up to 12-ft. size are employed either in single or double span for all sizes. Estimates made when the contracts were let indicated the cost of these culverts to be only 10 to 15 per cent greater than the cost of pipe and headwalls. For spans of 20 to 30 ft. steel I-beams and concrete slab construction was adopted. For long spans, pile and frame bridges were planned with the expectation of replacing them at the expiration of their life of 7 to 10 years with steel spans having concrete floors.

Two reasons counseled the use of temporary structures for long spans. One reason was the belief that in building the permanent structures later there would be a saving over present prices. The second and more important reason is one which prevails widely in river bottom lands whose reclamation by drainage is under way or is a future probability. With drainage many existing creeks and sloughs, which require bridging, will be eliminated by main ditches. Until reclamation plans disclose which of the present openings will be permanent and what new openings must be provided, plans for permanent bridges are impracticable.

Unit bids were taken on each of five sections, each section being an intra-county unit. This was necessary because there was suspicion among the property owners that in some way one county might be made to bear a portion of the expense in some other county. By taking bids, using each county as a section, the effect was to satisfy the property owners in this particular, since they could determine just what the cost of construction in each county would be. They were also convinced that whatever advantage any county had by reason of shorter hauls and other conditions was reflected in the unit prices. Under the plan of improvement in Arkansas, it is practically impossible to let construction contracts, otherwise than on a unit basis to the end that quite definite costs of construction can early be determined.

This project shows very clearly the heavy risk involved from a contractor's standpoint, when large mileages are bid upon, and a construction bond for the full 100 per cent cost of the work is furnished. This

FIG. 4. AVERAGE CONDITIONS OF CLEARING AND GRUBBING

is particularly true in times of wide fluctuation of labor and material prices as has been the case since these contracts were started. In addition to the great hazard of weather and other conditions there has been the exceedingly heavy increases in freight rates, this item alone involved an increased cost of approximately $175,000.

In addition it has been rather difficult for the contractor to obtain prices on materials which would hold

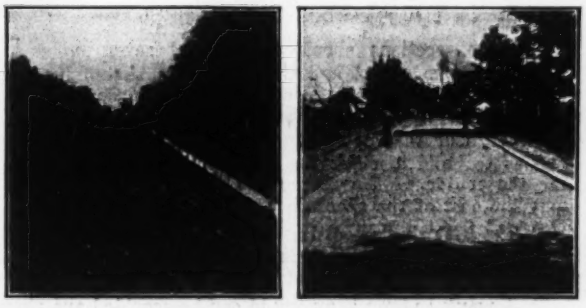


FIG. 5. SUBGRADE AND CONCRETE BASE

(The first view shows the condition of gumbo embankment, ahead of concrete mixer, after a rain, and which has been cut up by wagons hauling sand and gravel on a portion of the line where an industrial railway is not in use. This condition looks extremely bad, but the soft and muddy portion is only two or three inches deep and this soft material is removed before the concrete base is laid. The second view shows the method of roughening the concrete to improve the bond of the asphalt top.)

throughout the contract requiring 3½ to 4½ years to complete, and it is the writer's judgment that in all large contracts requiring two or more years to complete the contractors should be safeguarded and protected against many of the increases of cost which have occurred in this particular piece of work. It would seem fair also, in the future, that contracts of this size should permit the storage of construction materials as rapidly as possible with the District carrying the cost of materials and the freight thereon. The contracts provided for a maintenance bond of one year's duration after the completion of work on the macadam sections and a maintenance bond covering a 5-year period on the asphalt sections. However, on the asphalt portions, the contract provides for the acceptance and release of the reserved percentage and the date of the maintenance being started on 5-mile sections.

The contractors' organizations on the work presents no unusual features, however, it seems apparent, as indicated by the progress made by one of the contractors, that an assistant superintendent is of great advantage in any organization where so much machinery is used, and where work is proceeding with so many units constantly employed. The time spent in traveling about and seeing the different foremen and sub-foremen daily can be advantageously delegated to an assistant superintendent giving the superintendent all of his time for planning and safeguarding in various ways to avoid delays.

So far as possible the contractors have tried to avoid the use of camps and while the towns are close and provide housing facilities for the men, yet it seems very evident to the writer that this construction could be carried on much better (as has been proven heretofore in railroad construction) if portable camps were provided and moved along with the work. This method has the advantage of a smaller labor turnover and the added advantage of the foreman at all times having his labor where is can be reached and started to work without delays and loss of time.

The construction cost of the project, exclusive of interest charges on the bonds issued, will approximate $3,300,000, the entire amount of which, with the exception of $332,000 Federal and State Aid, will be paid from taxes assessed on the real property in the District. The work was taken by the engineers in charge on a percentage fee basis with provisions for additional compensation after time limits fixed in the contract for

FIG. 6. ROADBED FLOODED BY BACKWATER FROM RISE IN MISSISSIPPI RIVER

the completion of the work have been exceeded. The long time required to complete this particular project indicates that this form of contract is rather hazardous on the part of the engineer.

A chart, Fig. 7, is given showing the engineering organization and its relation to the Board, and other agencies, this organization being similar to the engineering organizations used 15 to 20 years ago in handling long extensions in railroad construction. The division engineers render weekly force reports on printed forms to both the resident engineer and the engineers in charge, and the resident engineer renders a weekly general report giving a summary of the work accomplished by each contractor, with delays to all plants and reasons therefor, together with any changes made in contractors' organizations and equipment, and also a record of construction materials received during the week. Inspectors render daily signed reports on standard forms as does aso the asphalt laboratory. Monthly reports are rendered the board by the engineers in charge, with a map covering progress and other details, at which time estimates are approved and vouchered. The engineering personnel is a follows: Ford & MacCrea, engineers in charge. A. R. Alling, office engineer; W. W. Mitchell, resident engineer at McGehee; J. R. Kline, R. L. Turrell and K. W. Lefever, division engineers. The contractors are as follows:

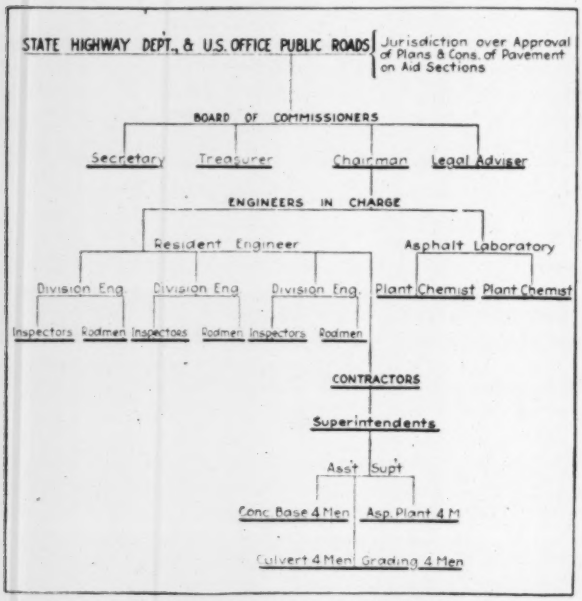



FIG. 7. CONSTRUCTION ORGANIZATION CHART

The Bryant Paving Co., Waterloo, Iowa, Chicot County Section, 57.51 miles, approximate amount, $1,284,000; The White Construction Co., Chicago, Ill.; Desha and Drew Counties Sections, 55.67 miles, approximate amount, $1,242,000; The Burke Construction Co., Fort Smith, Ark., Ashley County Section, 28.57 miles, approximate amount, $290,000; The Healey-Feild Construction Co., Denison, Tex., Lincoln County Section, 11.87 miles, approximate amount $184,000

## Railway Electrification Plans in England

A committee to consider the question of electrification of railways was appointed last year by the British Ministry of Transport, one particular subject assigned being that of regulations to ensure such standard practice as to permit of interchange of rolling stock and uniformity of equipment. According to *The Engineer*, London, the report of the committee makes little advance toward standardization. Although in effect it recommends a 1,500-volt direct-current system as a future standard (which system is as yet little used in England) it also provides for continuance of the 600- and 1,200-volt and single-phase systems now in operation, their extension to be subject to the approval of the government.

Further, it provides also for the approval of systems using 750 volts or some other multiple of 1,500 volts. That standardization is likely to prove undesirable is the opinion of *The Engineer*, as a considerable amount of electrification has been carried out and it is doubtful whether any one particular system can be the most suitable for all railways. In fact, for the electrification of long lines it may be found that a higher pressure than 1,500 volts would result in considerable saving in cost of construction and operation. Several projects are under consideration by the railway companies but nothing is likely to be done until some definite position is taken by the government as to the future of the railways, the lines being still under government control.

# Lessons of Patrol Maintenance

AFTER three years of full patrol maintenance of trunkline highways in Wisconsin, the lessons learned and the ideas successfully put into operation are summarized by J. T. Donaghey, maintenance engineer, as follows:

(1) A poor earth road may be changed to a good one for from $100 to $300 per mile by the use of a heavy blade grader and a large tractor.

(2) Width and smoothness of surface are of more importance than low grades.

(3) Where a patrol maintenance system is in operation no road should have more than a 4 to 6-in. crown for a 24-ft. shoulder to shoulder roadway.

(4) An application of 2 to 3 in. of sandy gravel, not larger than ¾ in. in size, on the surface of a clay road will give excellent results. Small stock piles of the material should be deposited along the roadside for the patrolman's use in strengthening the weak places. Ruts will occur, but persistent light grading or planing will result in an excellent and cheap temporary surface.

(5) Many roads ordinarily called "sand roads" can be converted into very satisfactory roads for light traffic by moving in to the center with a blade grader, the new top soil from the roadside for a wearing surface and keeping the surface smooth with a grader or planer. The bad sand requires a mixture of clay if available; if not, a covering of cedar shavings, marsh hay, straw, fine brush or weeds.

(6) Patrol sections should not exceed seven miles in length for team patrol and the patrolman should live on the section and as near the center of the section as possible. Where a competent patrolman cannot be secured who lives near the center of a section, it is economy for counties to build a shack for the patrolman to be located near the center of the section. The saving of time will repay the cost of the shack in two seasons or less.

(7) The best single tool for the patrolman's use in keeping the road surface smooth is the four-wheeled, two-horse road grader; next is the road planer.

(8) A wavy, uneven gravel road can be scarified and then reshaped with a grader at a cost of from $50 to $75 per mile, resulting in an excellent road. If new material is required it must be of a size passing a 1-in. ring.

(9) A 9-ft. gravel or macadm road can be scarified and widened to 16-ft. by covering the old surface and 3½ ft. of each shoulder with from 2 to 3 in. of fine graavel. The persistent use of the light grader or planer will produce a well-compacted surface without the use of a roller. This is both an excellent and a cheap method.

(10) A 9-ft. stone or gravel macadam road can be successfully widened to 16 ft. by resurfacing with 2 to 3 in. of stone, extending the stone over 3½ ft. of each shoulder and binding the new material with bitumen. If the road is properly constructed, the 3-in. depth of stone on the shoulder will amply care for reasonably heavy traffic.

(11) A badly worn macadam surface can be maintained more cheaply by the application of about 2 in. of sand and this will result in a more satisfactory road to travel than if a surface treatment is applied. It must be gone over frequently with the road grader or planer.

(12) No road should receive a bituminous surface treatment except where the surface is smooth and clean and when bitumen is used it should be of a quality and sufficient in quantity to penetrate the road surface thoroughly. Holes appearing in the surface should be patched immediately by the patrolman. It is a waste of funds to apply surface treatments and not use an absorbent of stone chips, pea gravel or torpedo sand. The surface treatment of roads taking care of heavy traffic that have been previously treated should be continued, provided they have been properly maintained.

# Effects of Motor Operation Costs on Highway Location and Grade Design Summarized

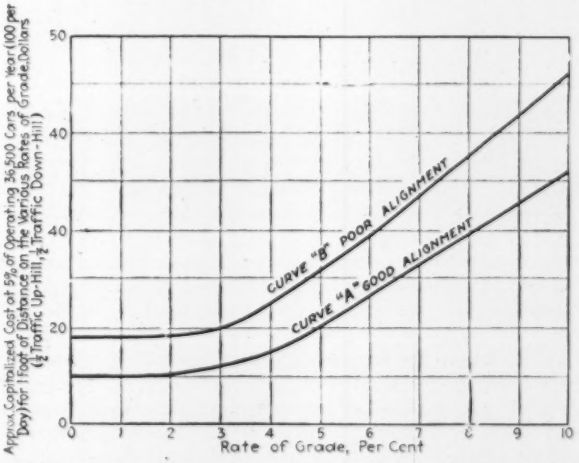
By Wilson G. Harger
Formerly Senior Highway Engineer, U. S. Bureau of Public Roads

*This article supplements the one published in three parts beginning in the July 15, 1920, issue of "Engineering News-Record," p. 104, on the effect of motor operation costs on highway location and grade design. It has been written in response to a large number of requests as to the practical use of the approximate rather theoretical data previously given and to give a more definite idea of the effect of dangerous alignment. There is a very practical application of these figures. In any short article it is not possible to demonstrate the various detailed uses, but general rules may be summarized. The previous article was only intended to develop general principles. This article supplements it by some practical suggestions in the form of simple rules and simple methods of comparison which place a reasonable money value on proposed relocations.*

*Effect of Alignment*—Dangerous sharp alignment increases motor operating costs. It decreases normal speed and results in the needless use of second or low gear climbing and excessive braking on down grades. This action only occurs, however, on a very small percentage of the distance on a well designed road, viz., at the danger points. That is, if the alignment is safe for traffic it does not affect the operating cost. If it is dangerous for traffic it does affect the operating cost. As real danger is a more vital matter in the design than cost of operation, alignment design is controlled by the factor of safety and not by considerations of operating cost. In other words, danger will be eliminated if it is possible to do so, and no consideration of cheaper operation would improve the alignment if the consideration of danger had not been sufficient to warrant it.

While there is no good data on the effect of alignment on operating cost, we have enough general data to state with reasonable assurance that if the radii of curvature are not sharper than from 250 to 300 ft. on the level or less than 400 to 600 ft. on grades and the sight distance is not less than 250 ft., reasonable speeds need not be reduced on account of alingnment and motor operating costs are not materially affected. For sharper curvature and shorter sight distance the cost of operation is probably increased. How much, we do not know, but purely as a matter of academic interest the author has modified the factors used in compiling diagram 2 for usual alignment, to conform with certain observed speeds on dangerous alignment. Diagram 1 shows the result. Curve A represents safe alignment. Curve B represents dangerous alignment.

We may say, both from the standpoints of safety and operating costs, that it is desirable to design special service commercial roads for a sight distance of about 350 ft. and local service or secondary state routes for about 250 ft. Considerable expenditure is justified to obtain this requirement, but large additional cost in order to further increase the sight distance is wasteful and poor engineering, particularly on roads of secondary importance. This caution is not a needless one, as the author has recently heard designers excuse excessive profile and section grading on the score that it increased the sight distance beyond the 350-ft. limit. This limit is not necessarily proper or liberal enough for all conditions, but it seems good sense to arrive at some limit suitable for the road in question and then eliminate additional expenditure for an additional sight distance which may be fine to have if you can afford it, but which is really not necessary. The tendency of almost all departments working with large appropriations is gradually to increase the *fancy extras* which may not amount to much for one idea but grow in number like a snowball until you wonder why the cost of roads is going up and the mileage for your appropriations coming down.


Approx. Capitalized Cost of 5% of Operating 36,500 Cars per Year (100 per Day) for 1 Foot of Distance on the Various Rates of Grade. Dollars
(½ Traffic Up-Hill, ½ Traffic Down-Hill)
50
40
30
20
0
CURVE "B" POOR ALIGNMENT
CURVE "A" GOOD ALIGNMENT
0 1 2 3 4 5 6 7 8 9 10
Rate of Grade, Per Cent

1. APPROXIMATE EFFECT OF DANGEROUS ALIGNMENT ON MOTOR-OPERATION COSTS

The practical application of the analysis given in the previous articles can be summarized in the form of simple rules:

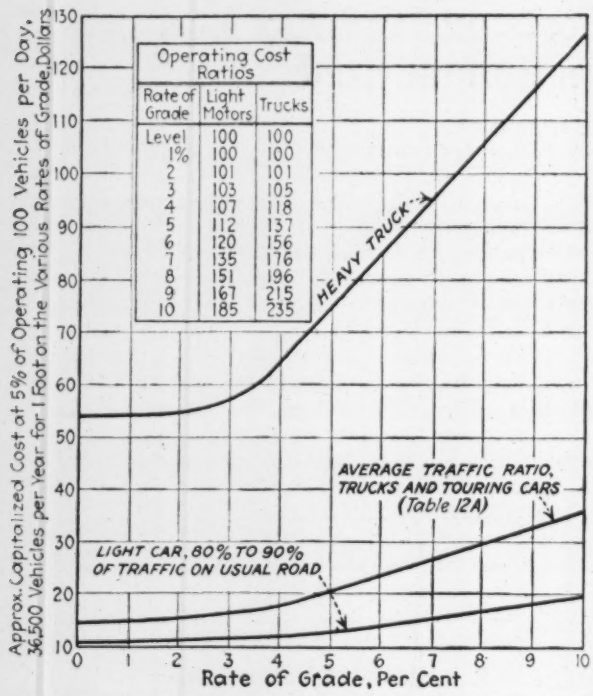
Climatic, drainage and soil conditions govern a location in respect to avoiding bad snow conditions, flood areas, needless stream crossings, slide or swamp formations and excessive rock work. The general requirements of line and grade discussed in the previous article are summarized as follows: The various principles are repeated conversely under the headings of grade, alignment, distance, rise and fall, and cut and fill grade reductions.

1. *Reasonable maximum grades are essential.* Recommended reasonable rates for various kinds of roads are given below. The following treatment is allowable to get a reasonable maximum:

(a) Any expenditure necessary.

(b) Distance may be increased in order to get a reasonable maximum grade but should not be increased for a fixed rise to reduce grade *below* a reasonable maximum.

(c) Poor alignment may be used if necessary to get a reasonable maximum grade if funds are low, but poor


Approx. Capitalized Cost at 5% of Operating 100 Vehicles per Day, 36,500 Vehicles per Year for 1 Foot on the Various Rates of Grade, Dollars
Operating Cost Ratios
Rate of Grade | Light Motors | Trucks
Level 100 100
1% 100 100
2 101 101
3 103 105
4 107 118
5 112 137
6 120 156
7 135 176
8 151 196
9 167 215
10 185 235
HEAVY TRUCK
AVERAGE TRAFFIC RATIO, TRUCKS AND TOURING CARS (Table 12A)
LIGHT CAR, 80% TO 90% OF TRAFFIC ON USUAL ROAD
Rate of Grade, Per Cent

2. DIAGRAM OF DATA GIVEN IN PREVIOUS ARTICLES

alignment should never be introduced to reduce grades *below* a reasonable maximum. Where poor alignment is necessary maximum rates must be reduced at the danger points (see below).

(d) For a fixed rise and distance, it is generally better to use a short length of reasonable maximum and for the balance of the distance a low rate, than to use a uniform moderate rate grade for the entire distance; this is not strictly in accord with the principles of cheap motor operation (diagram 3) but the net practical results are generally better. This means that if a road is running up a valley on an easy grade and must leave the bottom land and climb on a side hill location to reach a pass, it is generally better to make the climb as short in distance as possible, as a side hill location usually introduces poor alignment and generally increases the excavation per mile over a valley location.

2. *Alignment should be made as safe as possible considering the funds available.* Safety of traffic governs alignment practice. Cost of traffic operation has no practical effect.

(a) Good alignment should never be sacrificed to reduce grades below a reasonable maximum. For safe alignment practice see below.

(b) Good alignment may be sacrificed to get a reasonable maximum, but this condition necessitates the reduction of grade at the danger points (see below).

(c) Improved alignment warrants increased distance only when danger is eliminated. Increased distance is not warranted merely to make an easy curve easier.

(d) It is better to use a steeper grade (up to a reasonable maximum) with good alignment than to use poor alignment and a lower grade.

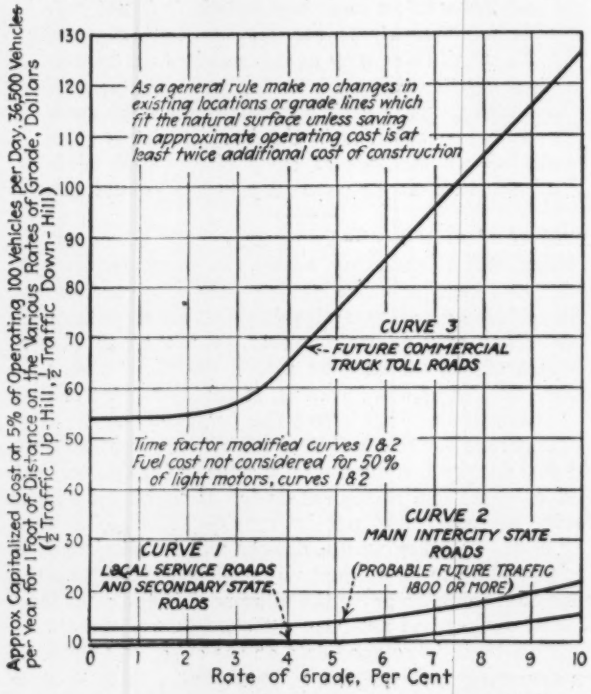
(e) Exceptionally good alignment (practically straight) may in some cases warrant an increase in the reasonable maximum grade above the rates recommended below. This modification would not, however, apply unless it were impossible to locate and grade the lower rate location so that the sight distance on it was at least 250 feet.

(f) An alignment and grading design which results in a sight distance of 250 to 350 ft. is safe and desirable but large expenditures to increase still further the sight distance must be used with caution unless the funds are unlimited. Increase in maximum grade above the recommended maximum in order to increase sight distance above 250 to 300 ft. is rarely warranted.

3. *Short distance is desirable provided considerations of safety, rise and fall, or reasonable maximum grades do not modify the conclusions.*

(a) Distance may be increased to reduce danger by better alignment at bridge approaches, railroad crossings or to avoid difficult topography. Recommended minimum radius of curvature are given below.

(b) Distance should be increased to get a reasonable


Approx Capitalized Cost at 5% of Operating 100 Vehicles per Day, 36,500 Vehicles per Year for 1 Foot of Distance on the Various Rates of Grade, Dollars (½ Traffic Up-Hill, ½ Traffic Down-Hill)
As a general rule make no changes in existing locations or grade lines which fit the natural surface unless saving in approximate operating cost is at least twice additional cost of construction
CURVE 3
<- FUTURE COMMERCIAL TRUCK TOLL ROADS
Time factor modified curves 1 & 2
Fuel cost not considered for 50% of light motors, curves 1 & 2
CURVE 2
MAIN INTERCITY STATE ROADS
(PROBABLE FUTURE TRAFFIC 1800 OR MORE)
CURVE 1
LOCAL SERVICE ROADS AND SECONDARY STATE ROADS
Rate of Grade, Per Cent

3. PRACTICAL BASIS OF COMPARISON, ALTERNATE LOCATIONS, ALIGNMENT ASSUMED TO BE FAIRLY GOOD

The costs given are conservative for curves 1 and 2. Further investigation and experiment will undoubtedly increase these values rather than reduce them.

maximum for a fixed rise, but rarely to reduce the grade below a reasonable maximum for a fixed rise.

(c) Distance should never be increased to reduce rise and fall on grades of 2 per cent or less.

(d) Distance may be increased to reduce rise and fall on grades over 2 per cent (use diagram 3 for comparisons of this kind), but for grades not exceeding the maximum it is rarely desirable to increase distance unless a noticeable rise and fall can be eliminated by a small additional distance. For ordinary easy rolling topography the principle of the straight line location is generally sound.

4. *The elimination of needless rise and fall is desirable, modified by certain conditions.*

(a) The elimination of rise on steep grades is desirable. Distance may be increased to accomplish this, provided the disadvantage of increased distance is balanced against the value of less rise (see diagram 3).

(b) The elimination of rise on grades of 2 per cent or less is of no value from a practical standpoint.

(c) Adverse grades may be used to eliminate dangerous alignment or shorten distance provided the shorter distance is of more value than the disadvantage of the extra rise (see diagram 3).

### Summary of Cut and Fill Grade Reductions

Grade reductions by cut or fill assume that the road location is fixed for some reason and that further improvements must be by cut or fill. The distance is always fixed. Reasonable maximum grades are essential.

(a) For a fixed rise there is no practical advantage in reducing the rate of grade below a reasonable maximum.

(b) Reduction of total rise and fall on steep grades is desirable.

(c) Reduction of rise and fall on light grades has no practical advantage.

(d) The use of short adverse grades of 2 per cent or less on a long climb has no practical disadvantage.

The sources of justifiable economy in cut and fill design lie in the use of the short maximum in connection with the long ruling grade and the use of a rolling grade profile for all intermediate rates.

The application of these principles in conjunction with the "spotting method" of profile design generally results in a satisfactory road at a moderate grading cost. The violation of these principles of location and cut and fill profile design occur quite frequently.

### Maximum Grade

From the standpoints of horse traffic, single unit motor traffic or trucks with one trailer, safe footing and economy of construction and maintenance the following recommended rates of maximum grades will give moderately good satisfaction. In unusual cases the possibility of the extensive use of long trailer trains would tend to reduce these recommended rates but the author wishes to emphasize the opinion that very few roads need be designed at this time primarily for long trailer trains. The following rates are satisfactory for the ordinary motor equipment used by the great majority of road users and additional expenditure would not be warranted for the benefit of a few men.

*Main Commercial Roads in Flat Country*—Long 2 per cent ruling grades are desirable but do not justify much additional construction cost. Any long ruling grade up to 5 per cent will probably be satisfactory. Short 6 per cent grades are not inconsistent. A large volume of hauling by trailer trains might warrant reductions below usual practice provided the interests operating such haulage paid the increased cost of construction.

*Main Commercial Roads in Hilly Country (Well Settled Districts)*—Long 5 per cent ruling grades are desirable and justify considerable expenditure provided they do not increase the total distance. Seven per cent grades are probably justified to prevent increase in distance for a fixed rise. Long 6 per cent grades are fairly satisfactory but as a rule if 5 per cent cannot be reasonably obtained it is just as well to jump to 7 per cent. Short 7 or 8 per cent grades are not inconsistent in connection with long 5 and 6 per cent grades provided the element of safe team footing is considered.

*Main Roads Pioneer Districts*—Long 5 per cent grades are very desirable provided they do not increase the total distance, particularly if the road is a natural soil road and considerable horse traffic prevails. Any long grade up to 7 per cent is fairly satisfactory. Short 7 and 10 per cent grades are not inconsistent except for trailer trains. Grades higher than 7 per cent are not, however, in much favor on account of danger and high maintenance cost.

*Side Agricultural Roads or Unimportant Pioneer Roads*—Any long grade up to 7 per cent is satisfactory. Short 10 per cent grades are consistent in connection with a 7 per cent ruling provided the element of safe footing is considered. Grades steeper than 7 per cent, however, have a high maintenance cost.

*Scenic Roads*—Long 6 per cent grades are convenient on account of preventing gear shifts. Ten per cent is not unreasonable for such roads except that on a 10 per cent grade the alignment should be easy, as later discussed, and the maintenance cost is high.

*Effect of Alignment on Grade (Mountain Roads)*—On sharp curves it is desirable for the driver to have first-class control on the score of safety. An extremely sharp curve with a large central angle also reduces the hauling capacity of a six-horse team by from 20 to 40 per cent. Considering both safety and team hauling it is, therefore, desirable to reduce ruling grades on sharp curves. These considerations have no practical value on mountain roads for curves having radii greater than 100 ft., but on sharper curves good practice recognizes this principle. Ordinary design uses radii of from 40 to 80 ft. on difficult switchback turns. For a 40-ft. radius the grade should not exceed 3 per cent; for an 80-ft. radius 4 per cent is a reasonable maximum.

*Effect of Alignment on Grade (High-Class Roads, Well Settled Districts*—Good practice reduces grade to 3 per cent or less where the sight distance is less than 250 ft. or where the radius of curvature on a steep grade is less than 400 feet.

The following summary agrees with general current practice and can often be used without raising the cost beyond the bounds of reason. A summary of this nature is of course of only general value. Each case must be worked out on its own merits. Broad generalizations of detail requirements are dangerous if used indiscriminately.

| | |
|---|---|
| Main Commercial Roads (Well Settled Districts): | |
| Minimum sight distance | 300 to 400 ft. |
| Minimum radius of curvature at right angle turns on level outside of villages where sight distance does not control | 250 to 400 ft. |
| Minimum radius of curvature on steep grades or at the foot of such grades where the sight distance is not the controlling factor | 400 to 600 ft. |
| Ordinary Agricultural Roads (Local Service): | |
| Minimum sight distance | 200 to 250 ft. |
| Minimum radius of curvature at right angle turns on level outside of villages | 100 to 200 ft. |
| Minimum radius of curvature on steep grades where sight distance does not govern | 300 to 400 ft. |
| Mountain Roads: | |
| No limitation on sight distance. | |
| Warning signs used where necessary. | |
| Minimum radius on steep grades | 100 ft. |

Minimum radius in extremely rought country, 40 ft. Grades not to exceed 3 per cent for a 40-ft. radius and not to exceed 4 per cent for an 80-ft. radius. And grade up to 8 per cent on a 100-ft. radius, although it is desirable not to exceed 5 per cent on a 100-ft. radius curve with a large central angle.

It is hoped that the foregoing simple rules and recommendations will dispel any uncertainty that the reader of the previous articles may have had as to the practical use of the analysis.

---

## Mystery Solved: Workman Forgot To Open Valve

According to the *Canadian Engineer* it has been found after two years of poor water pressure in the business part of Chatham, Ont., that the trouble was due to the failure of a workman to open a force-main valve at the pumping station after it had been closed for repairs.

*A Banker's Analysis—*

# The Outlook for Business

By Francis H. Sisson
Vice-President, Guaranty Trust Co. of New York

*Digest of an address delivered Jan. 20 before the annual meeting of the American Society of Civil Engineers in New York City.*

THE question uppermost in the minds of business men all over the world, is, "When will present readjustments be completed and a stable basis for business re-established?"

We may arrive at a better understanding of the problems presented by the present situation, perhaps, if we recall some of the important factors that have created existing conditions. The tremendous losses caused by the World War, of course, were primarily responsible for them. While it is impossible to arrive at an accurate computation of the costs or to reduce all of them to a monetary basis, it may be helpful to remember some reasonable estimates which conservatively place the gross monetary loss at approximately two hundred billion dollars (although other estimates run as high as three hundred and thirty-seven billion dollars); the known dead at ten million and seriously wounded at six and a quarter million; the total property loss at thirty billion dollars; the loss in man-power, measured in money, at one hundred and eighty billion dollars, and the national debts of the world in 1920 at two hundred and fifty-five billion dollars, as compared with forty-four billion dollars in 1914.

## How Allies Were Aided

To meet the exigencies of war, the people of this country sent billions of dollars' worth of food, fuel, and munitions to Europe. We lent nearly two and three-quarter billions of dollars to the Allies through subscriptions to their bond issues and by extension of banking and commercial credits. We supplied the Allies with two and a half billion dollars more by re-purchasing American securities held abroad. When we entered the war we placed ten billion dollars in credit, of which nine and a half billions were used, at the disposal of the Allies. Since the armistice we have supplied foreign countries with one and one-quarter billions of dollars by absorbing various foreign bond offerings here and have advanced commercial credits to the aggregate, it is estimated, of about three billion dollars.

The period of unusually active business and rising prices, following the war, was characterized by a wave of extravagant buying by domestic consumers. This was made possible by an increase in purchasing power, as is indicated by the fact that the per capita circulation of money in the United States increased from $37.31 on Nov. 1, 1914, to $59.48 on Nov. 1, 1920, and was $59.12 on Jan. 1, 1921. Speculation was rampant. Capital expenditures in preparation for meeting the unusual demand on the part of the public for goods naturally tended to be excessive in many instances. In the first ten months of 1920 industrial financing broke all records, with an aggregate of more than two billion dollars in bonds, notes and stocks. During the corresponding period of 1919 the amount totaled more than one billion, six hundred million dollars, which was the record up to that time. This period was also characterized by extraordinary demands on the part of foreign countries for American goods, and those demands continue very heavy.

While, of course, years must elapse before the tremendous amount of life and property destroyed in the war can be fully replaced and the political and social problems it has created can be solved, there is ample ground for believing that we shall reach a relatively stable condition in this country in the very near future. We have undoubtedly passed through the most critical of our post-war readjustments, although many more must yet be made. It is encouraging to note, however, that the period of inflation apparently has passed, as is evidenced by the fact that during the last few weeks Federal Reserve notes to the value of $245,000,000 were retired from circulation. But any answer to the question that business men and others are seeking is contingent upon the length of time it takes to effect the remaining necessary readjustments.

I refer especially to the readjustment of retail prices to declining wholesale prices and the readjustment of the costs of production to present purchasing power. These necessary readjustments have been tardily started, as was to be expected, but they are now under way, fortunately, and will be completed gradually but with ever-accelerating speed. The sooner they are accomplished, with a minimum of distress, the sooner we will reach a comparatively stable business basis, but we cannot reach that basis until they are finished.

## Problems of Readjustment

The adjustment of production costs will involve, and, in fact, will consist, chiefly of wage adjustments, although increased efficiency and decreased margins of profits must also play their part. As wages generally are reduced, of course, there will be curtailed purchasing power, but it should be remembered that decreased costs of production will lower commodity prices which will ultimately offset the reduced buying capacity of the public. The laborers who profited most from ever-soaring wages during the war and for some time after will feel the curtailment first and most, but they should be in a better position to bear it than their less fortunate fellow-workers. Those wage-earners and salaried workers whose incomes were little affected during the last five years and who suffered most from inflated prices will be afforded an increasing measure of relief from now on.

So there are compensating factors in the situation, deplorable as it is that some members of our body politic must always be penalized in periods of inflation and others be distressed in periods of deflation. That is only one of the many reasons why all of us at times would like "to mould the universe more to the heart's desire."

The curtailment of production which inevitably accompanies such industrial readjustments as we are now experiencing, however, will finally prove its own corrective. We are not in the throes of over-production, but merely temporary under-consumption. And it is significant, in this connection, to note that when goods are offered for sale at retail prices which the public believes to be fairly commensurate with prevailing wholesale prices and costs of production they are eagerly bought.

Despite the materially lessened purchasing power in agricultural sections, occasioned by the precipitate decline in the price of farm products, and in certain indus-

trial sections, because of closed plants or the part-time operation of factories and reductions in wages, there is still a tremendous buying power in the United States and always will be. When purchasing is resumed on a large scale it will be all the keener by reason of the delay and the deficits in present commodity stocks.

Thus, the existing situation is even now devising its own corrective, and the pendulum of business activity which has now swung to the two extremes of its arc is already returning to the mean of that arc. As a consequence of this movement, those commodity prices that have sagged too low will rectify themselves while the prices that have soared too high will reach their true level. And wages, which should not be considered in the light of money values but rather in that of purchasing power, will be more equitably adjusted on a sounder economic basis than at present—which will be as beneficial to labor, in the end, as to the whole business community. Wages cannot be sustained on an uneconomic basis any more than can farm products or any other commodities. All necessary liquidations must run their course, and the sooner and franker we face that fact and discount its inescapable consequences the better off we shall be.

The producers and merchants who persist in holding their goods for prices that the public will not pay are courting disaster and preparing to swell the number of commercial failures. They have not learned the elemental rules of successful merchandising that profits come from turning over capital. They are endeavoring to ignore the inexorable law of supply and demand. They are trying to shape business to their liking in ignorance, apparently, that practically every business today is directly or indirectly affected by world conditions that no individual or nation can control.

### Foreign Trade

American business men must recognize the vital fact that one of the most important factors in our prosperity henceforth will be our foreign trade. The extent to which our overseas trade is sustained and increased will depend to a large degree upon the methods devised for financing it. And that is quite as much the concern of the business man, whether or not he is directly interested in exporting or importing, as it is of the banks, for the only way we can preserve our present prosperity is adequately to finance our foreign commerce and thereby keep our industries running at normal capacity, for our productive capacity is greater than the demands of our domestic markets. Our domestic prosperity, in fact, depends largely on our success in disposing of our surplus production abroad. And in order to finance our foreign trade adequately, the banks must have the co-operation of the farmers, the manufacturers, and business men generally.

The business conditions of this nation are fundamentally sound. But, after the great crisis through which we passed in the world war and in which we demonstrated our tremendous economic strength, we have relaxed and permitted ourselves to be bound like a Gulliver by lilliputian uncertainties and pessimistic reactions. With the richest and most abundant resources, facilities, and capabilities of any nation on earth we stand on the threshold of the New Year in the rôle of a Doubting Thomas, lacking faith in our manifest destiny, supplanting the eagle with the ostrich as our national emblem.

Leadership that will direct our national thought into logical channels is imperatively demanded at the beginning of 1921. And it will be the duty, as well as the opportunity, not only of the incoming Administration but also of Congress to assume that leadership. It is equally the duty, as well as the opportunity, of American business interests to co-operate fully in giving the country such leadership.

# Specialized Use of Mechanical Equipment Features Road Job

## Sand Screened From Pit Direct to Motor Trucks—Bucket Elevators Discharge Aggregate From Stockpiles to Trucktractors

By W. F. Welsch
Assistant Engineer, Bronx Parkway Commission, New York City

RATHER unusual methods were adopted in the construction of the Bronx River Parkway Drive, extending from Scarsdale to White Plains, N. Y., a distance of about two and a half miles. The high cost of labor and a general demand for economy resulted in the concentration upon the use of mechanical equipment. The type of construction on that particular contract is asphalt block on a concrete foundation. The width of the paved roadway is 41 ft., including a 6-in. concrete edging on each side which is laid integral with the concrete base. Asphalt blocks are 5 x 12 x 2 in. are manufactured at Hastings-on-Hudson, N. Y., and shipped direct from plant to the job in motor trucks.

FIG. 1. SAND SCREENED FROM PIT TO TRUCK

The blocks are laid on a ½-in. mortar bed, the joints being sanded. The concrete base is a 1:3:6 mix, the bottom of the slab being a straight line from the center of the roadway to each side and having a rise of 3 in. from each side to the center. The top of the finished concrete base is a parabolic curve, the concrete being 7 in. thick at the center and 5 in. thick at the sides. The finished pavement has a 5-in. crown.

Equipment used in the placing of the concrete foundation and edging consisted of two one-bag batch mixers; three 1-yd. tructractors; two loading machines, and three 3½-hp. pumps for furnishing water from the Bronx River, which parallels the drive. Cement, sand and crushed stone were delivered to the road in 6½-ton capacity motor trucks. Due to possible delays in materials shipments if shipped by rail, the cement and crushed stone were shipped in barges, unloaded at the dock at Hastings-on-Hudson, and delivered to the road at an average haul of eight miles. The sand for the concrete was obtained about two miles from the work where it was screened directly from the pit into automobile trucks, having a capacity of 4 cu.yd., by means of a path-digging loader equipped with a screening device. The device consisted of a screen attached to the top of the loading machine with a power-vibrator attachment. In screening sand was deposited in the truck and overs were diverted into a deflector chute at the bottom of the screen and deposited alongside the trucks.

After being transported to the job, the sand was stockpiled on the subgrade along one side of the road at intervals of 10 ft., the crushed stone dumped on the other side of the road at intervals of 5 ft., in piles of about 4 cu.yd. each. The roadway was left clear for the transportation of cement and other materials, where necessary, to the mixer. The two concrete mixers were operated abreast, one on each side of the road, the concrete being placed, in one operation, for the full width of the pavement. Two loading machines were used in the handling of the crushed stone and sand. The stone was elevated from the stone piles in traveling buckets on the loading machines to measuring bins having the capacity required for a one-bag batch, and the sand was handled in the same manner by loading machines at the sand piles. The three-wheeled tructractors delivered the crushed stone and sand to the loading skips of the concrete mixers. The tractors traveled up to the sand loader, where the tractor operator opened a bin and received his charge of sand, and then drove to the stone loader, receiving a charge of stone, the mixture being delivered into the mixer hopper. Under ordinary conditions three tructractors were used around the mixers, and hardly ever was there any appreciable congestion.

The operating crew on concrete work consisted of thirty men distributed as follows: Two mixer operators,

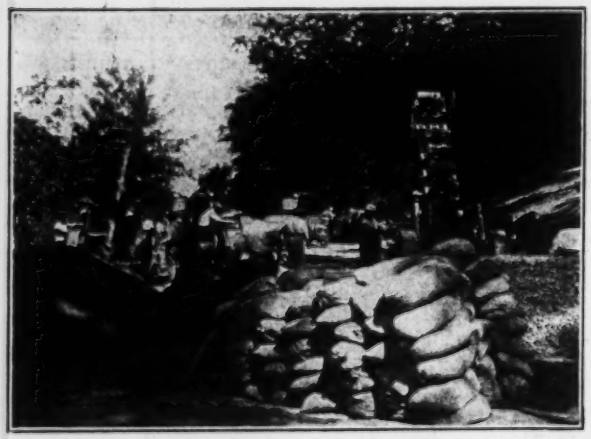


FIG. 2. STOCKPILING PLAN AND LAYOUT OF MECHANICAL EQUIPMENT

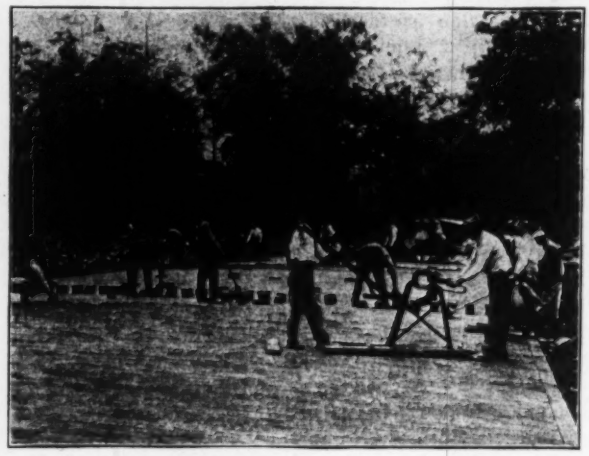


FIG. 3. LAYING ASPHALT BLOCKS ON MORTAR BED

two loader operators, three tructractor operators, two concrete rakers, two chute men, two spreaders, two men handling cement at hoppers, five men placing forms, two men placing grade pins, etc., and four men delivering cement from storage piles to the mixers. An average rate of construction per day of 300 lin.ft. of 41-ft. road was maintained. Expressed in other terms, this is a rate of 260 cu.yd. of concrete per day.

The engineering and construction work upon the Bronx Parkway Drive was under the supervision of Jay Downer, engineer-secretary of the commission. L. G. Holleran is deputy chief engineer and Chester A. Garfield is field assistant engineer in charge of construction contracts. The writer acted as resident engineer on the construction of the pavement herein described. Leslie B. Farr was general superintendent for the contractor, the Hastings Pavement Co.

## Dry Rot of Timbers

As applied by many persons any decay which is found in wood in a comparatively dry situation is called dry rot. Thus loosely used, the term actually includes all decay in wood, since wood kept sufficiently wet cannot decay. To the pathologist the term dry rot means a certain fungus, *merulius lachrymans*, which gains its distinction from the fact that it is frequently found growing in timbers without any apparent moisture supply. In reality it does not grow without moisture and is as powerless as any other fungus to infect thoroughly dry wood, according to the Forest Products Laboratory. Given moist wood in which to germinate, it is able to make its way a surprisingly long distance in dry timbers, drawing the water it needs from the moist wood through a conduit system of slender minutely porous strands. Wood in the typical advanced stage of dry rot is shrunken, yellow to brown in color, and filled with radial and longitudinal shrinkage cracks, roughly forming cubes. In many instances these cracks are filled with a white felty mass, the interwoven strands of the fungus. The decayed wood is so brittle and friable that it can easily be crushed into powder.

The dry rot fungus is active in nearly every region of this country, in Canada and in Europe. It is destructive to factory and house timbers and to logs in storage. Coniferous or soft woods are more commonly infected by it than hardwoods.

# Report Constructively Criticises California's Road Policy

## More Substantial Concrete Pavement, Shorter Life Bonds, Budget for Test Department, Among Auto Clubs' Recommendations

FAILURE of paved highways in California, have become frequent in the past two years and consequent criticism of state highway standards and construction methods has been so general that the board of directors of the California State Automobile Association and the Automobile Club of Southern California decided to institute an engineering and economic study of all the paved state highways to determine their present condition, their sufficiency in width and their adequacy to carry the ever increasing volume and weight of traffic." In accordance with this announcement, made by the two California automobile clubs, engineers were retained who have just submitted the results of studies extending over a period of six months, in the form of a comprehensive report. This report is now being printed and, pending its appearance, a synopsis of the findings has been prepared and signed by four of the engineers who took a leading part in the study, namely, J. B. Lippincott, consulting engineer, Los Angeles, H. J. Brunnier, consulting structural engineer, San Francisco, Charles Derleth, Jr., Dean of civil engineering, University of California, and Walter C. Howe, consulting highway engineer, San Francisco. Some of the chief points in the findings are presented in the following extracts taken practically verbatim from the synopsis:

The California Highway Commission construction programs of 1913, 1914 and 1915 are highly commendable. Cleanness of administration and absence of scandal have been noticeable. Wilful waste and extravagance cannot be charged and honesty of purpose is freely admitted. It has been the first object of the present study to be constructive in criticisms. Where road failures have been found, an attempt has been made to determine the cause and indicate possible remedies with a sincere desire to profit by successes and failures.

*Highway Commission Policy*—The commission has lacked foresight and vision in failing to carry out adequate and sufficient experimentation, research and investigation in a broad and comprehensive scale. It has not taken advantage of the few experiments it did make. Until October, 1920, the commission used practically the same type of construction throughout the state, irrespective of traffic, sub-soil or drainage. Such a policy is economically and structurally unsound and open to grave criticisms. Despite innumerable failures of 4-in. concrete road, the commission has continued to build roads of this section in numerous instances under practically the same conditions and upon heavy sub-soils of questionable and uncertain character.

Through a headquarters policy which must be classed as most narrow and shortsighted, the responsibility of the division engineer has been so circumscribed that at times his work has resolved itself into mere routine. This robs the division of its individuality, kills the initiative of the division engineer and affects the entre division organization.

*Present Condition of the State Highways*—In southern California field inspections indicate as high as 30 per cent of the concrete pavement in poor condition, requiring reconstruction now or at an early date. An additional 19.3 per cent is in only fair condition, serious failure having already begun. This leaves only one half the pavement in this section in what might be termed good condition. In general, inspections in the southern part of the state have indicated higher percentages of failure than in the northern portion where the failure area is 17.7 per cent and pavements in fair condition aggregate 20 per cent, leaving 62.3 per cent of these pavements in good condition. Pavement failures are closely related to soil conditions. In the South 70 per cent of the failures have occurred on adobe subsoils; on sand, gravel or decomposed granite, from 70 to 75 per cent of the concrete roads are in good condition.

*Recommended Types of Construction*—It has been stated by the chairman of the highway commission that "The concensus of opinion of our engineers is that the reinforcing of the concrete highway is equivalent to thickening it at least 2 in." Tests show that a 6-in. plain concrete slab has a greater traffic capacity than 5-in. sections reinforced as proposed. Therefore, this statement has little foundation in fact. A 5-in. concrete slab is not thick enough to meet heavy traffic requirements. A study of maintenance charges and reconstruction costs during the past seven years leads to the inevitable conclusion that it is more economical to build thicker and more substantial pavements.

For trunk roads an average pavement thickness not less than 6 to 8 in. is recommended, dependent upon sub-grade drainage and traffic requirements. Where the sub-soil is treacherous and yielding, the pavement requires an amount of reinforcement proportional to the foundation difficulties to be overcome.

It is recommended that clays and adobes be adulterated by rolling into them such materials as sand, gravel or broken stone. Everything should be done that will tend to limit the tendency for change in adobe volume with change in moisture content. The shoulders should be not less than 3 ft. in width wherever the clay or adobe is questionable.

Greater width of permanent paved roadway is of extreme importance. Fifteen-foot pavements without shoulders are unsatisfactory and dangerous. The width of all double-track highways should never be less than 18 ft. on tangents and should be widened on curves and grades. Future traffic demands a minimum width of 20 ft. on important roads and near cities, or, wherever traffic is heavily congested, the width should be not less than 24 ft.

*Traffic and Traffic Laws*—During the past four months 2,000 trucks were weighed as they passed over state highways; 256 of these were found to be overloaded, in some instances as much as 100 per cent. Five hundred trucks gave rear-wheel loadings ranging from 4,275 lb. for 1-ton trucks to 11,280 lb. for 5-ton trucks. The California law provides a maximum weight of 800 lb. per inch width of tire in contact with the road. By actual measurement on 500 trucks the average load per inch width of tire on one rear wheel ranged from 831 lb. on 1½-ton trucks to 1,090 lb. on 5-ton trucks. The maximum load per inch width measured was 1,840 lb. More important than limiting the maximum load per inch width of tire is the need for limiting the maximum load put on any one wheel. The maximum load usually found on rear wheels of 3½-ton and 4-ton trucks is approximately 10,000 lb. The speed averaged 18.4 mi. per hour for 1-ton to 13 mi. per hour for 6-ton trucks.

California has completely neglected to enforce the laws relative to overloading the pavement slabs. There must be co-operation between truck dealers, truck operators and the state authorities in the enforcement of proper traffic laws. California should adopt a uniform motor vehicle law.

*Research and Investigations*—In work of the magnitude of the California highway program sufficient funds should be set aside for the continuous study of special problems. Some of these are (1) pressure capacity of sub-soils, tests of heavy clays and adobes, drainage and alkali, (2) tests on full-sized pavement to determine the relative advantages of reinforcement vs. greater thickness of slab and varying richness of mix, as well as a study of different types of reinforcement, (3) traffic studies to determine the effects of impact, roughness of pavement surface, design of trucks, etc.

*Public Opinion*—Public opinion in California demands more permanent types of construction, rather than mileage of highway. Public will not continue to support frail construction with long life bonds.

*Conclusion*—It is not intended that this report should convey the impression that the committee is opposed to the construction of concrete highways. The contrary is true. The committee believes that the most satisfactory type of pavement to stand heavy traffic conditions is an adequately and properly built concrete slab. The California Highway

Commission, while perhaps not legally and technically responsible for some of the conditions described in the report is, nevertheless, the state's authority having general supervision over the highway program. The commission and its engineering staff must take responsibility for the present highway situation.

Judging from past experience, all future work should be subject at intervals to careful inspection and review by competent representatives of the people.

## Kansas Highway Bridge Conditions

### Concrete Much Used—Cement Prices and Deliveries Troublesome—Roadway Widths—Many Twenty-Ton Vehicles

REPORTING to the Kansas Engineering Society at its meeting held Dec. 16, 1920, the bridge committee of the society (F. W. Epps, chairman, L. P. Scott and R. V. Leeson) reviewed the present problems and conditions of highway bridge construction in the state, pointing out some significant tendencies. It laid emphasis on roadway widths and load capacities, factors which are proving a puzzle in all parts of the country, and also referred to commercial difficulties which now hamper the construction of concrete bridges. The average cost of concrete in bridge construction during the past year is set at $30.69 per cu.yd. The report follows, slightly condensed:

Twenty years ago the popular type of bridge in Kansas was the steel truss span supported on either masonry or concrete abutments. In many cases these bridges have been neglected and allowed to rust out at vital points until they have failed under the modern loads which pass over them.

With the development of the cement industry, the price of cement has been lowered and the quality improved, until some five years ago, when the concrete structures were cheaper and far better than the steel ones. This period of cheap concrete bridges taught the public the advantages of this type of structure and they are now unwilling to go back to the old types. At present the concrete bridge work is being hindered by the fact that it is very difficult for the contractor to get his cement at a reasonable price and get delivery within a reasonable time. One instance is recorded where a contractor was unable to get cement from the local dealer, so he hauled it from the plant 45 miles away in his trucks. When his bill was presented it included the freight to the job and the local dealer's profit.

Many types of bridges are used in Kansas, but by far the most common is the concrete slab or T-girder span, as determined by the length required. In some counties steel spans have been used for the longer bridges, but always with a concrete floor. Other counties are more progressive and use the higher types, such as the through girder or the arch.

#### Minimum Roadway Widths Recommended

More trouble is experienced in Kansas with the proper regulation of clear roadways of bridges than with any other feature of bridge design. The law places a lower limit on the width of roadway but does not attempt to set any standards for the different classes of bridges. Section 9, Chapter 80, Session Laws of 1917 states that bridges must have a clear roadway of at least 16 ft., and culverts 20 ft. The bridge specifications of the state highway commission for 1917 recommended roadways as follows: For bridges 18 ft. and for culverts 24 ft. This has been supplemented by the requirement made on federal-aid roads, that bridges must have a width 2 ft. greater than the width of pavement on the road, which generally gives a 20-ft. clear roadway, and that culverts must have a roadway equal to the distance between the shoulders of the road.

While one would suppose that the Western counties would be the ones to call for narrower roadways, as their traffic is lighter and the need for economy greater, just the reverse is true, and the counties that object most strongly to doing more than complying with the law are located in the eastern part of the state.

Your committee wishes to go on record at this point as recommending the use of the following roadways: On township roads, bridges, 18 ft. standard but never less than 16 ft.; culverts, 24 ft. standard but never less than 20 ft. On county, roads, bridges, 20 ft. standard but never less than 18 ft.; on culverts, 28 ft. standard but never less than 24 ft.

In highway loadings the same trouble is experienced as in railway loadings. The loads are constantly increasing and old structures are becoming obsolete and too light for the modern trucks. This is shown on railroad work by the numerous replacements which are made by the larger railroads, many of which are made on bridges that are apparently in good condition although they are not heavy enough to carry the modern loads. Our truck loads are increasing as rapidly as railroad loads, and at present we find that there are in the neighborhood of 30 tractors in Kansas which have a capacity of 20 tons, which is the loading specified by the state highway commisssion for designing bridges in the state. This would indicate that it would only be a matter of time before the present bridges will be depending on their factor of safety to carry the load, and new bridges will have to be designed for a heavier loading.

Strange circumstances are often encountered at bridge lettings, such as at recent letting in one of the northern counties where about $70,000 worth of work was advertised. After contemplated the bids, which were below the estimate on all bridges, the commissioners rejected all bids without any explanation to the five contractors bidding on the work. It is also interesting to note that this county has not let a bridge contract for three years.

The total amount of bridge work approved by the state highway commission up to Dec. 1, 1920, was $2,301,981.05, while the total amount of bridge work approved since the commission started has been $4,475,178.91. The average cost of concrete bridges in Kansas during the past year is $30.69 per cubic yard. This price covers culverts as well as larger bridges.

## Teakettles Better than Coffee Pots for Asphalting Pavement Cracks

ALTHOUGH coffee pots are used as vessels from which to pour asphalt into highway pavement cracks, the California highway commission has found that teakettles with a long and well-curved spout are superior for this purpose. The stream poured from a coffeepot, being an overflow, cannot be directed into a narrow crack accurately and is likely to be sprayed over the pavement by the wind. The long spout of the teakettle, on the other hand, delivers a stream from an orifice under pressure; the stream is round, or nearly so, holds together well in a wind and can easily be directed to the exact spot required. The curved spout of the teakettle also prevents drippings from running down the sides of the vessel and with a little care in filling it at the oil heater, its handle and entire outer surface can easily be kept clean throughout the job. Small sprinkling pots, with the perforated tip removed, have also been tried, but are not considered as good as teakettles.

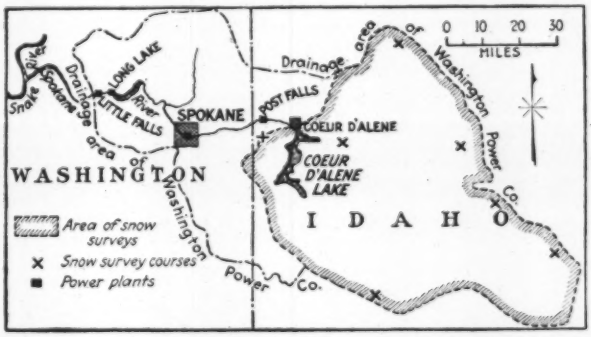
## Stabilizing Softened Water

The latest step toward stabilizing a lime-softened water is the use of home-made phosphoric acid to produce a fully carbonated water free from any residual causticity. Laboratory experiments to effect this result have been under way many years and many chemicals have been tried both at Columbus and elsewhere. C. P. Hoover (p. 81) has now gone far enough to use the whole Columbus plant in an experiment with phosphoric acid.

# Snow Survey for Water Power From Spokane River

## Forecasts of Run-Off From Snow Fields Will Aid Economic Operation of Four Plants and Conserve Water Supply

A SYSTEM of annual snow surveys on the Spokane River watershed above Cœur d'Alene Lake, in Idaho, is to be inaugurated by the Washington Power Co. in order to secure data from which forecasts of the probable spring run-off may be secured, thus increasing materially the efficiency of operation and preventing unnecessary waste of water. The accompanying map shows the area to be covered and also the four hydro-electric plants on the Spokane River which are owned and operated by the company and which use the water stored in Cœur d'Alene Lake.




SNOW SURVEY COURSES ABOVE COEUR D'ALENE LAKE

These plants have a total normal rating of 93,050 kw.: Post Falls Island, 11,250 kw.; Spokane, Monroe St., 8,800 kw.; Long Lake, 52,500 kw.; Little Falls, 20,500 kw. The first of these is in Idaho, where the lake and the watershed to be surveyed are located.

The snow surveys will be made at the close of winter and before melting begins, in order to ascertain the amount of water in storage in the form of snow on the watershed. No attempt will be made to ascertain absolute quantities in storage, but it is believed that the relative amounts from year to year can be secured. The methods used will be essentially those adopted on the Lake Tahoe Basin, as developed by Prof. J. E. Church, Jr., of the University of Nevada (see *Engineering News*, May 29, 1913, p. 110; *Engineering Record*, April 17, 1915, p. 494; and *Engineering News-Record*, Oct. 23, 1919, p. 766).

Snow courses are selected at certain index points where the wind effect is minimized by topography or timber, these courses being indicated on the map. In the spring the snow is sampled and its water content measured at about 50 points on each course, the average being taken to represent the water in storage at that station. The run-off from each major portion of the drainage area is measured and compared with the amount of water in snow storage previously determined. In this manner it is hoped to develop a relation between the total spring run-off and the water previously held in snow storage at the index stations from year to year.

The problem is complicated by many factors, including spring rains, rapidity of melting, winter thaws or chinook winds prior to the effectual spring run-off. In order to secure data from which allowances for these factors can be made, two climatalogical stations are being installed in addition to those maintained by the U. S. Weather Bureau. At these stations temperatures, atmospheric pressures and precipitation of rain and snow will be noted continuously, besides which a certain amount of snow sampling will be carried on. Elevations on the area to be covered by the snow surveys vary from 2,120 ft. at the lake to more than 7,000 ft. on the eastern divide. The present plans contemplate the use of seven or eight well-distributed snow courses at elevations of from 3,000 to 6,000 ft., but it is hoped that this number can be reduced to four stations after the characteristics of the area have been studied for a few seasons.

Each of the four power plants noted above uses water stored in Cœur d'Alene Lake, the controlling works being located at Post Falls, nine miles below the lake outlet. At this point the river is in three channels, on the middle of which the power house is located. To control the lake level the north channel has two bear-trap dams each 53 ft. in length operating between El. 2,116.5 and El. 2,126.5; also seven 21-ft. openings and one 12-ft. opening controlled by Taintor gates above El. 2,116.5. In the south channel there is a dam with six gates each 6 ft. wide by 13 ft. high, with sills at El. 2,108.6. The extreme range of water level in the lake is 17.6 ft., from El. 2,120 to 2,137.6, as determined from records covering 29 years, and the company has secured by purchase and condemnation the right to hold water on all lands above Post Falls to El. 2,126.5. The natural rise of the lake has reached or exceeded that elevation in all years of record except 1905.

For control of the lake level above El. 2,126.5, all the gates at Post Falls are opened wide and the bear-trap dam is lowered in advance of the spring rise. After the natural spring flood peak has passed and the lake level has receded to El. 2,126.5, the bear-trap dam is raised and the lake level is held to that elevation by manipulation of the Taintor and other gates until the inflow has fallen to that required for power and irrigation. When this condition is reached all gates are closed and all water is passed through the Post Falls turbines and is used by the other plants in succession.

Snow survey work will be initiated under the direction of John C. Stevens, consulting engineer, Portland, Ore., and will be in immediate charge of J. B. Fisken, consulting engineer for the Washington Water Power Co. Whether it will be continued as a permanent institution will depend upon the results secured during the first few years.

---

### New District for Alaskan Forest Reserves

Alaska has been designated by Secretary Meredith of the Department of Agriculture as a new national forest district and Charles H. Flory has been appointed district forester with headquarters at Juneau.

The two national forests in Alaska—Tongass in the southeastern section and Chugach in the Prince William Sound country—have previously been under the supervision of the Forest Service office in Portland, Ore. The change to a local administration has become necessary, it is announced, in order to handle efficiently the products of these national forests, which are increasing in importance.

# Subgrade Support in Pavement Design

## Corners Are Danger Points in Paved Roads—Capillary Seepage Destroys Supporting Power of Subsoils—Tentative Slab Formula Proposed

By Clifford Older
Chief Engineer, Division of Highways, Illinois Department of Public Works, Springfield, Ill.

REGARDLESS of the supporting capacity of the subgrade, the weak points of rigid slab pavements are the corners formed by the intersection of cracks and joints with each other and with the edges of the pavement. On the truck traffic roads of Illinois many broken corners have been observed in all types of rigid pavements, and only in a single instance has a traffic break been observed that was not readily traceable to the piecemeal breaking down of corners or narrow strips formed by longitudinal cracks making acute angles with the edge of the slab. The exception was an asphalt top on a 1-3-5-concrete base 4 in. thick at the sides and 5 in. thick at the center which broke into small pieces under excessive truck loads. An examination of the base showed that the transverse strength of the base had been exceeded not merely at corners but also at the edges and near the center of large slabs. No concrete slab or base 6 in. or more in thickness has broken except at corners.

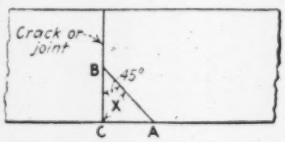


DIAGRAM ILLUSTRATING THEORY OF PAVEMENT DESIGN TO RESIST CORNER FAILURES

*Until it is possible to control completely the cracking of rigid slabs it seems obvious that the entire slab must be designed to carry the imposed loads at the weak-points—the corners.*

*Subgrade support of corners.*—Preliminary investigation by the Illinois Highway Department confirms the findings of the U. S. Office of Public Roads that the supporting capacity of clay soils is greatly decreased as the percentage of moisture increases. Further investigations have developed the following data:

(1) Illinois' corn-belt clay soil rapidly absorbs sufficient moisture to render its supporting capacity near the surface almost nil.

(2) Under the center of an 18-ft. concrete slab one month old, laid on a subgrade on which no rain had fallen for six weeks, the subgrade soil was found to contain about 17 per cent moisture after a two days' drizzling rain.

(3) The subgrade under pavements laid on both cut and fill sections with 6-ft. earth shoulders, but without tile drains, appeared practically saturated when investigated three or more days after the beginning of a rainy period.

(4) A very narrow crack will permit the passage of large volumes of water to the subgrade. The practical saturation of the subgrade soil for several feet each side of a narrow crack is but a matter of a few hours' time during a period of continuous rain or melting snow.

(5) The repeated passage of heavy wheel loads over corners, even when such corners are supported by comparatively dry clay subgrades, causes, within certain limits, a progressive depression of the soil under the corners.

These investigations, although not as yet extended enough to be conclusive, indicate strongly that it may be difficult, if not economically impracticable, by any system of drainage, combined possibly with a water proofing of the subgrade, to maintain a clay subgrade dry enough to afford any reliable support to the corners.

*Method of Design.*—In developing a tentative method of design the following assumptions are made:

(1) As corners are obviously weaker than other portions of the slab only the corners need be considered.

(2) Until erratic cracking can be controlled it is necessary to build all portions of the slab on the basis of corner strength.

(3) Considerations of economy prohibit the use of reinforcing steel as a srength factor. Many calculations have been made by the Illinois department in an attempt to find an economical design of reinforcement.

(4) Until conclusive observations of the dependable supporting capacity of subgrade soils can be made, taking into account the possible control of the moisture content, *support of corners by the subgrade should be practically neglected.*

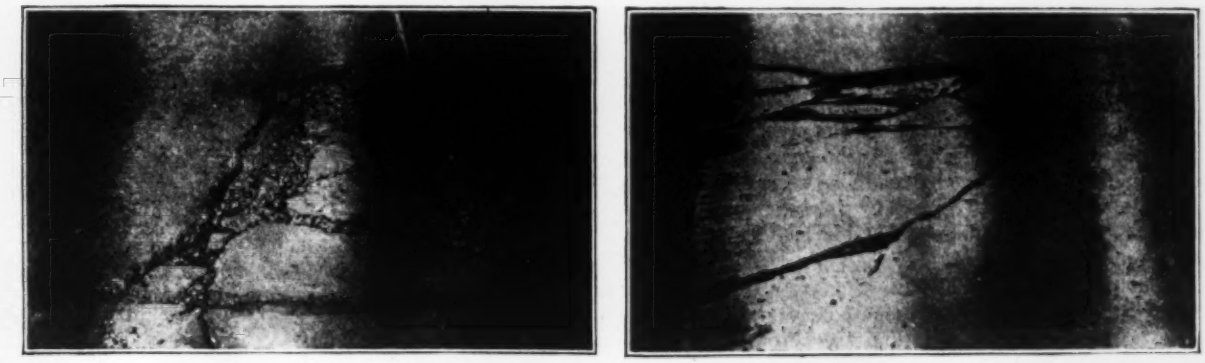
(5) When bituminous filled expansion joints are omitted, and frequent dividing planes with dowel pins

CORNER FAILURE, CONCRETE PAVEMENT

or tongue and groove joints are used, so that erratic transverse cracks may not be expected to open materially, a wheel load placed on one side of a joint or crack near a corner may be considered as divided equally between the adjacent corners or slabs. (It is suggested that contraction joints be formed by galvanized or painted corrugated sheet metal or metal sheets so bent as to provide tongue and groove joints.)

(6) When bituminous filled expansion joints are used or when frequent contraction joints are not used, thus increasing the probability of the wide separation of occasional cracks, the entire maximum wheel load should be considered as supported by one corner.

(7) The effect of impact on a rigid slab constructed strictly in accordance with rigid specifications as to surface smoothness may be considered as offset by subgrade support. The improbability of the maximum wheel load ever being applied at the point causing maximum moment provides an additional factor of



TWO OTHER EXAMPLES OF CORNER FAILURES OF CONCRETE PAVEMENTS IN ILLINOIS

safety. (Observation of the pointer of an Ames dial set to measure the deflection of corners failed to show visible vibration during the close passage of moving truck wheels. These tests were made on a federal aid section of concrete road constructed by contract with no attempt to secure unusual smoothness. It is possible, although not probable, that impact vibration, too rapid to be detected by ordinary means, may have been present.)

(8) The necessity for designing for tensile fiber stress only need be considered.

In Fig. 1 $W$ = maximum wheel load, one-half of which is to be considered as applied at $C$.

$x$ = the distance from the load to the critical section equal the moment arm.

$AB = 2x$ = the critical section located on a line making an angle of 45 deg. with edges of slab.

$S$ = the allowable tensile stress of the material forming the upper surface of the transverse strength element of the slab.

$d$ = the depth of the slab.

$I$ = the moment of inertia of a cross section of slab at the critical section $= \frac{2 x d^3}{12}$.

$M$ = bending moment $= wx$

Substituting these values in the formula $S = \frac{Mc}{I}$, this formula reduces to $S = \frac{1.5W}{d^2}$ or $d = \sqrt{\frac{1.5W}{S}}$.

Assuming the whole load carried by one corner only, this formula would become, $S = \frac{3W}{d^2}$ or $d = \sqrt{\frac{3W}{S}}$.

It is to be noted that at right angled corners the critical section may be at any distance from the loaded point. In practice the subgrade under the corners of a heavy double line traffic slab will be depressed more than elsewhere, leaving the subgrade support some distance back.

Perhaps it would be safer to consider the entire wheel load as carried by one corner, although the few experiments so far made in Illinois show equal deflections of adjacent corners when such corners are formed by narrow cracks or dowelled dividing planes, the load being imposed upon one corner only.

If one corner only is considered as carrying the whole load, then the above formula is undoubtedly on the safe side if the pavement is built with a sufficiently smooth surface to reduce impact to a negligible quantity.

The accompanying views show corner breaks in a pavement 6 in. thick at the sides, and 8 in. thick at the center, composed 1:2:3½ wet mix concrete, with a roller and belt finish. No expansion joints were used; header boards provided dividing planes at the end of each day's work. The breaks were all at corners formed by rather wide cracks, and were definitely known to have been caused by certain trucks hauling crushed stone.

In accordance with the above formula and assuming no subgrade support or mutual support of adjacent corners, the fiber stress in the concrete would figure about 750 lb. per square inch. The actual stress developed at the right angled corners was no doubt less than this as it would have been impossible for the entire wheel load to come upon the extreme corner. The modulus of rupture of the concrete was not known, but probably was between 500 and 600 lb. per square inch.

Only twelve corners were broken out of several hundred which existed in the length of road used by these trucks. The fact that all corners were not broken was probably due to partial subgrade support and to partial mutual support of adjacent corners, but largely to the fact that the loaded trucks traveled close to the edge of the 18 ft. slab only when passing empty trucks going in the opposite direction. There was no traffic on the road aside from the stone trucks. The loading of the corners, therefore, occurred only at infrequent intervals when trucks passed at cracks or joints. A total of about 1,500 loads was hauled. This instance would seem to afford a rough check on the formula.

*Further Research Planned.*—Further investigation of slab deflections and stresses; the effect of mix, type of wearing surface, etc., on modulus of rupture; the supporting capacity of soils with varying moisture content; the variation of the moisture content and supporting capacity of such soils under pavement slabs at different seasons and with different types of drainage systems; the compression of soils under repeated loads; the possibility of largely controlling the location of longitudinal and transverse cracks by sheet metal divisions; the mutual support of adjacent slabs afforded by friction of the rough surfaces at cracks; the mutual support of adjacent slabs which may be secured by artificial means at dividing planes, and other items affecting the transverse supporting capacity of pavement slabs, is being carried on in connection with a two-mile test road being constructed by the Illinois Highway Department and at favorable points on old pavements.

The test road was designed to determine as far as possible the load supporting capacity of various types of pavements, laid on a uniform subgrade as affected by

thickness and other elements governing transverse strength.

Great care was used in selecting the site in order that uniform subgrade, alignment and grade conditions might prevail. The road will be closed to public traffic until the test is complete. Upon the completion and the curing of the pavement the road will be subjected to an artificial truck traffic, gradually increasing in weight until the legal load limit of Illinois has been exceeded by about 50 per cent.

Four principal types of pavement are used: macadam base with brick and bituminous concrete wearing surfaces, concrete base with bituminous top, concrete base with monolithic and soft filler brick top, and one course concrete. Generally each test section is 200 ft. long. The series of sections for each type begins with a thickness roughly estimated as equivalent to 4 in. of concrete and increases to the approximate equivalent of 9 in. of concrete.

The behavior of the subgrade before and during loading will be observed by means of pressure cells secured from the United States Office of Public Roads, and by means of special observation devices consisting essentially of sections of iron pipe set in the slab, protected at the top by removable plugs and containing a loose brass disk in contact with the subgrade. By means of an inner pipe this disk is forced down when the pavement deflects under load and remains in contact with the subgrade as the slab recovers. Thus a means is provided to observe, with an Ames dial, the permanent or temporary depression of the subgrade. The supporting capacity of the subgrade may also be observed at any time by loading the disk. By removing the disk moisture samples may be obtained.

A descriptive bulletin is being prepared which will give in detail the design of the various sections, methods and control of construction, description and use of special apparatus, observations under way and contemplated, plan of loading, etc. It is expected that the loading will be started in July or August, 1921. It is hoped that when completed the above briefly described investigations may aid materially in determining a rational method for the design of rigid slabs. In the meantime the foregoing provisional method of design is suggested for use.

### Typhoid and Some Other Death Rates in 1919

Deaths from typhoid fever in the registration area of the United States in 1919, according to the Census Bureau, totaled 7,860 in a population of 85,147,892, giving a typhoid rate of 9.2 per 100,000. Typhoid caused 0.7 per cent of the total of 1,096,436 deaths for the year. Suicide exceeded typhoid as a cause of death, there being 9,732 reported cases of suicide, giving a death rate of 11.4 per 100,000. Tuberculosis (all forms) caused between 13 and 14 times as many deaths as typhoid, the total number of tuberculosis deaths being 106,985—or 125.6 per 100,000 and 9.8 per cent of all the deaths for the year. Pneumonia was a close second to tuberculosis and influenza was also high, the death rates being 123.6 for the first and 98.8 for the second. Going to the other extreme, small pox caused but 358 deaths and a death rate per 100,000 of only 0.4 in 1919. The general death rate for 1919 was 12.9 per 1,000, the lowest on record in the registration area, which now includes 33 states, the District of Columbia and 18 cities in non-registration states.

## Steel from Slag Concrete Shows Little Corrosion

AN EXCELLENT condition generally of reinf .cing steel was disclosed by the recent wrecking of a 15-year old slag concrete building in Cleveland, Ohio. There was local corrosion and corrosion of individual bars or stirrups, where faults in construction coincided with possibilities for the accumulation of moisture, but the steel showed no evidence of general attack by rust. It appeared, on the contrary, notably clean and the faces of the concrete which had been in contact with the steel presented little discoloration.

APPEARANCE OF FLOOR SLAB REINFORCEMENT

The structure being wrecked is a four-story and basement building between two older buildings. It consists of wall columns and girders and two rows of interior columns connected by girders carrying a 4-in. floor slab designed for a load of 125 lb. per square foot. Construction was begun in 1905, continued through the winter, and was completed in the spring of 1906. The

CONDITION OF CONCRETE AND STEEL GIRDER END

concrete was a 1:2:4 mixture with a coarse aggregate of ¾ to 1 in. slag from Cleveland furnaces. Round bars, with pipe couplings, were used in the columns, but all other reinforcement was of twisted square bars, ½-in. for floor slabs and 1 in. for girders.

Generally the concrete was excellent but there were occasional places where it was porous or had not been worked to close contact with the steel and the steel in more numerous places was not covered with the proper thickness of concrete. These were the places where corrosion was found. There was also corrosion of the

slab rods in one panel containing the toilets and where there was well defined leakage from the plumbing.

Observation of the corroded steel indicated that where the concrete covering was shallow (less than one inch) moisture had penetrated to the steel, or that, by way of some local fault, moisture had worked along the bar between it and the enveloping concrete.

## Reclamation Service Achievements to June 30, 1920

PROGRESS in the reclamation of semi-arid lands by the U. S. Reclamation Service since June 17, 1902, the date of the approval of the reclamation act, is indicated strikingly by the statistics in the annual report of the Secretary of the Interior for the fiscal year ending June 30, 1920. Twenty-four primary projects and four Indian projects have been constructed in whole or in part at a net cost of $125,000,000. The value of crops grown in 1919 on lands served either in whole or in part from the works of the service amounted to nearly $153,000,000. About $89,000,000 represents the value of crops grown on the 1,113,469 acres of cropped land on the projects proper and the balance is an estimated amount from approximately 1,000,000 acres served with water under the Warren Act from the works of the service. Projects already completed will comprise ultimately an area of more than 3,300,000 acres.

The following projects reported crop values in excess of $100 per acre: Salt River, $126.27; Yuma, $134; Carlsbad, $106.04; Okanogan, $367.23; Yakima, Sunnyside unit, $167.07; Yakima, Tieton unit, $154.10. The annual farm census of the service shows that the value of products on reclamation projects, nearly $80, is twice as large per acre as the average yield on unirrigated land in the humid region.

The progressive increase in irrigable acreage, irrigated acreage, cropped acreage and crop value since 1913 on the service projects proper are shown in the table.

| Year: | Irrigable Acreage | Irrigated Acreage | Cropped Acreage | Crop Value |
|---|---|---|---|---|
| 1913 | 1,181,362 | 694,142 | 637,227 | $15,676,411 |
| 1914 | 1,240,875 | 761,271 | 703,424 | 16,475,517 |
| 1915 | 1,330,222 | 814,906 | 757,613 | 18,164,452 |
| 1916 | 1,405,452 | 922,821 | 858,291 | 32,815,972 |
| 1917 | 1,502,468 | 1,026,663 | 966,784 | 56,462,313 |
| 1918 | 1,601,934 | 1,119,566 | 1,051,193 | 66,821,396 |
| 1919 | 1,636,159 | 1,187,255 | 1,113,469 | 88,974,137 |

Special emphasis is laid in the report on the necessity of providing for adequate drainage on practically every project to prevent or check seepage and waterlogging of the soil and deposition of alkali. The problem is closely allied with that of the excessive use of water but irrespective of the methods employed in the delivery of water there will be a drainage problem on most projects since the escape of some water to the lower levels cannot be avoided. A large part of the funds available necessarily has been and must continue, according to the report, to be employed in the construction of drainage work, but the results accomplished fully justify the cost.

The Salt River project reported a total crop value of $23,000,000. This is more than twice the amount that the Water Users' Association is to repay to the United States over a period of 20 years, and most of this money will be supplied by power profits from the project works. On other projects the development has reached the stage where the annual crop value is comparable to the total cost of building the irrigation works as indicated in the following tabulation:

| Project | Value of Irrigated Crops, 1919 | Net Construction Cost to June 30, 1920 | Operation and Maintenance Cost, 1919 |
|---|---|---|---|
| Salt River, Ariz.[1] | $23,768,000 | $10,548,000 | (1) |
| Yuma, Ariz.-Calif. | 7,012,000 | 8,980,000 | $238,500 |
| Orland, Calif. | 892,000 | 965,000 | 23,200 |
| Minidoka, Idaho[2] | 5,926,000 | 5,820,000 | [2] 143,200 |
| Carlsbad, N. Mex. | 1,989,000 | 1,380,000 | 58,200 |
| Okanogan, Wash. | 1,951,000 | 1,093,000 | 33,500 |
| Yakima, Wash[3]. | 16,731,000 | 10,150,000 | [3] 210,000 |

[1] Works operated by Water Users' Association.

[2] Gravity unit operated by water users. Costs include storage works serving large area under Warren Act, for which crop returns are not here included.

[3] Costs include storage works serving areas under Warren Act for which crop returns are not here included.

Alfalfa continues to be the principal crop grown, covering 40 per cent of the acreage cropped. Wheat comes next with 15 per cent; then pastures, 10.3 per cent and cotton 9.7 per cent.

No new projects have been undertaken because of lack of funds. This condition results from the progressive decline in the receipts from the sale of public land, combined with the comparatively small returns from construction repayments resulting from the 20-year repayment law and the necessity of setting aside annually $1,000,000 to repay advances from the $20,000,000 revolving fund. It is expected that several million dollars will be transfered to the reclamation fund under the provisions of the act of Feb. 25, 1920, providing for leasing lands containing coal, oil, etc. The reclamation fund has received $100,078,476 from the sale of public lands, $493,330 from the sale of town lots and $20,000,000 from the revolving fund.

## Fire Danger in Parked Automobiles

Traffic congestion is not the only evil result of the custom of parking automobiles on city streets as the following note from the "Quarterly" of the National Fire Protection Association, January, 1921, indicates.

Chief John C. McDonnell, that capable and serious minded official who has continually in view, and very rightly so, the possibilities of a serious conflagration in Chicago, has broken silence in a communication to the local transportation committee of the Chicago City Council on a matter that is becoming more or less of an obsession to the fire chiefs of all our cities, and which must continually impress any thoughtful pedestrian in a city street: the choking of our street areas by the parking of automobiles and the difficulty of clearing the streets of them for the operations of the fire department in case of a big, quick-spreading fire. Most cities prohibit parking at the curb within 25 or 30 ft. of a hydrant, but this does not relieve the streets of congestion which frequently dangerously delays the fire apparatus in responding to downtown fires; nor relieve the firemen of the necessity of wasting precious moments in moving parked automobiles to make room for an effective handling of the apparatus. To safeguard cars against theft, special locks are provided, and when the fire occurs the owner of the parked car, the only person able to unlock it, may be at a matinee or in some remote part of the city. The operated cars themselves present a sufficient impediment at certain moments, as was sufficiently demonstrated at a spectacular fire in Salt Lake City last year, which occurred about shop-closing time and attracted such a number of spectators in automobiles as to close several avenues of approach to the second-call apparatus. Although but a few blocks away, the trucks dodged about for fifteen minutes before gaining successful access to the fire area. This matter of street congestion is one to which traffic experts may very well give their prayerful attention. There is untold potential danger in it to every city in North America.

# Highway Bridge Conditions and Requirements
## —*A Symposium*

**Modern Traffic Loads and Speeds in Relation to the Adequacy of Old Bridges—Official Views from Various States on Maintenance, Reinforcement and Permanent Construction**

REPORTING on methods of strengthening highway bridges, a special committee of the American Road Builders' Association recently stated, "It has been estimated that more than 80 per cent of the highway bridges are a distinct menace." One of the New Jersey highway commissioners resigned, a few weeks ago, on account of the serious condition of the state's road bridges; and at that time the commission made a demand upon the state legislature for an appropriation of several millions for immediately urgent bridge reconstruction, to be increased to a total of $18,000,000 within the next ten years.

These facts evidence a serious view of the highway bridge situation. A more optimistic view was presented by M. W. Torkelson, bridge engineer of the Wisconsin Highway Commission, in *Engineering News-Record* of Jan. 13, 1921, p. 61. Denying that the condition of highway bridges is a menace, Mr. Torkelson says, as to Wisconsin, "At the present rate of accomplishment we expect to keep ahead of our traffic problem."

In order to bring out the facts concerning highway bridges more fully, *Engineering News-Record* requested a number of state highway departments to comment on Mr. Torkelson's statement of the case. Their replies, given below, indicate that while in some states the bridge problem is merely one of maintenance, in others it is necessary to plan for large-scale reconstruction.

### A Program of Bridge Construction Vital

By Clarence L. Hussey
Bridge Engineer, State Board of Public Roads, Providence, R. I.

The views on the safety of old highway bridges expressed by Mr. Torkelson have been read with much interest and some concern. Apparently his purpose is to prevent unnecessary repairs to bridge superstructures, and the motive is commendable, but the effect, locally at least, may be unfortunate. Many public officials who by choice or expediency are acting without technical knowledge or proper advice will be overconfident through misinterpretation of this article. Funds required for bridgework may be diverted until a series of accidents results in loss of life, damage to property, and expensive emergency work. The fact that there are relatively few instances of actual collapse of bridges in service is not reassuring in itself.

The conditions affecting the construction and maintenance of bridges in Rhode Island are serious. There are *no limits in weight* or tire pressures of highway vehicles fixed by statute in this state, and there are therefore very considerable numbers of vehicles in use which weigh with their loads between 15 and 20 tons. Needless to say, a great many of our highway bridges are not capable of carrying such loads without grave danger.

The writer cannot endorse the opinion that old highway bridges are a secondary risk. Accidents at other parts of highways are not strictly comparable to accidents resulting from defects in bridges, because structural weakness is less evident and its consequences usually more serious.

Present maximum load requirements evidently do not vary much in different localities. Future loads, however, are speculative and should not be estimated too conservatively. Trucks with trailers approximating railway loadings are a possibility. Considering the locomotive as a parallel case, the increase in weight has been beyond all prediction. The writer feels that 20-ton loads should be a minimum requirement for all reconstruction, and that for permanent or semi-permanent structures this load should preferably be assumed as concentrated on a single axle.

Failure of plank or stringers is usually the first indication of overloading, though if heavy trucks were to cross our old truss bridges in close formation the trusses would be as likely to fail as the floor. Truck drivers instinctively operate at considerable headway, and failures usually occur in the order of plank, stringers, trusses and supports. Plank failures are common, and the writer has noted instances of badly bent floor stringers. Maintenance to the extent of relaying thicker plank and reinforcing the stringers in special instances generally is warranted, and the contention that this be taken as the usual limit of maintenance work is logical.

The writer believes that no exaggeration of the conditions of our old highway structures is necessary, that the simple facts are sufficiently disconcerting and that a program of permanent bridge construction is a vital issue in most of our states. In Rhode Island more than two-thirds of our state highway bridges are of concrete, designed for an indefinite future with ample provision for any reasonable increase of loading.

A reconstruction policy must of course be adapted to local conditions, but pending the erection of new bridges every precaution should be taken to insure the safety of our old structures. The writer believes that nearly all old highway bridges excepting some masonry arches involve elements of risk, many of them serious enough to be regarded as a menace to travel.

### Minnesota Bridge Conditions

By J. T. Ellison
Chief Bridge Engineer, Minnesota Highway Department, St. Paul

In Minnesota traffic has not as yet reached the density which is found on some of the eastern highways, but our highways and bridges are subjected to as heavy individual loads as is the case in any part of this country. Serious accidents resulting from the failure of bridges have been very few and far between, averaging not over one or two per year for the last four or five years. These accidents have in nearly every case resulted from the failure of the floor system of steel truss bridges which have been in place from 10 to 30 years, and in nearly every case the failure was due to the poor condition of the timber joists. I do not believe we have had a failure in this state involving the fracture of steel joists or tension members of a truss span. During the period following the year 1910, we had several failures due to the buckling of the top chord of trusses built on the section commonly known as

"T-chord." These bridges have been practically eliminated in this state, except for a few on minor highways.

Insofar as the main arterial highways of this state are concerned, one is absolutely safe with a load of 10 tons, provided reasonable speed is observed in crossing some of the timber floor bridges.

During the past years we have built many hundreds of bridges, primarily on the main arterial systems, and all of these bridges are designed for a 20-ton tractor, with 15 tons carried on the rear axle. This gives a very heavy floor system and I believe makes our bridges adequate for any load that is likely to be imposed upon them on the future. Of the bridges on the proposed trunk highway system of this state, between 65 to 70 per cent are of permanent construction and are safe for the above load, and I am of the opinion that within the period of the next five years practically every bridge on the trunk highway system will have been rebuilt or repaired to make it safe for the maximum load provided by our specifications.

## Bridges in Ohio Probably Better Than Roads

BY CHARLES ASH
Deputy Highway Commissioner, Ohio Bureau of Bridges, Columbus

A large number of timber truss bridges ranging from 40 to 200 ft. span are still in use in this section, and although many have been built and have been in use for over 50 years they are in a remarkable state of preservation. Several spans in excess of 200 ft. and located on main traveled thoroughfares give no indications of weakness and are constantly being used up to the 12-ton maximum limit allowed by the laws of Ohio. A notable exception to this statement is the timber bridge over the Scioto River near Waverly; this bridge has been condemned and an endeavor is now being made to replace it. As a general proposition the old timber truss bridges will carry the 12-ton load allowed. Of course the plank floor and floor joist must be looked after and replaced when necessary.

The older iron and steel bridges are as a rule in much poorer state of preservation than the old timber structures, due to lack of paint and a tendency to shave on the design. Some years ago there was quite a crusade against "tin bridges," and we have quite a few of the horrible examples still with us. Lack of proper bracing caused the destruction of a 200-ft. span in the northern part of the state; other shorter spans are standing for no very apparent reason. However, this type of bridge is not as common as its notoriety would indicate. There are hundreds of substantial steel highway bridges in all sections of the state which are giving little or no trouble to maintain.

Certainly one must put new floors on bridges, and if this is neglected trouble ensues. Local officials appreciate that a pavement must be maintained, but there is a tendency to take the stand that by some magic the pavement or floor of a bridge is good for the life of the bridge regardless of how many times the highway leading to the bridge is resurfaced or repaved.

The old masonry arches and culverts, which are rather numerous in certain sections, cause some little care. Occasionally a wing wall washes out or the side walls are undermined, but many old bridges which have stood the better part of a century are still in service and going strong.

All new bridges are designed for a 15-ton live loading, and although this is above the maximum loading allowed on a public highway by law there is no doubt that both old and new structures are called to carry not less than a 50 per cent increase over this load. The net result has been a few floor systems ruined,but no failures as to the bridge trusses themselves. In fact in the coal-producing sections, where excessive overloads have destroyed hundreds of thousands of dollars' worth of pavements, no bridge failures have been reported.

Design, construction, maintenance and repair of bridges in the state of Ohio is on a par with, if not in advance of, construction of pavements leading over these structures. This is due to the state law, that no bridge costing in excess of $10,000 can be built unless the plans and specifications have been approved by the highway department, which gives technical supervision of all bridges in the state, whether on state, county or township roads.

## Longitudinal Flooring Reduces Impact

BY JOHN N. MACKALL
Chief Engineer, Maryland State Roads Commission, Baltimore

The article by M. W. Torkelson, "Assuring Safety in Old Highway Bridges," covers in a general way the attitude held by the writer as regards old highway bridges on the Maryland state road system.

In Maryland the very few old highway bridges on the state roads are under the control of a district engineer, who is responsible for the inspection and maintenance of each structure in his district. Should repairs become necessary that can be made in the field, i.e., repairs to parts of the floor system, minor truss repairs, pointing or strengthening of masonry, they are made immediately. But if of a larger order, requiring extensive repairs to the trusses, or involving a large expenditure in proportion to the replacement cost, the repairs are not made. Instead, the bridge is rated and posted with respect to gross load and speed, and falsework is employed so as to enable, if possible, the permissible load to closely approach that allowed by law on the highways adjacent. This bridge is then placed on the list of primary or secondary bridges with respect to location, and in this manner it is comparatively easy to prepare the program each year of bridge reconstruction.

In order to increase the load capacity of certain old highway bridges it has been the practice in this state to decrease the impact effect by the use of a longitudinal flooring or longitudinal runways on a sub-flooring, together with proper approaches, and the effect obtained is so noticeable that laymen comment on the difference. The load permitted by law on the state roads system is 10 tons gross, and through the careful watch to prevent overloading by the Roads Commission it is but rarely exceeded. On the main highways are located scales on which to weigh trucks. Should there appear to be an excess load on a truck it is promptly removed until the gross load is within that allowed by law and the owner haled to the traffic court. In this way the overloading of trucks has been practically abolished.

All other bridges in this state are either under the control of the county commissioners, private companies or individuals, and may be regulated as to gross load permitted and rate of speed by state law. By this law, before any bridge can be posted with respect to load and speed an inspection of the structure must first be made under the supervision of the chief engineer of the state

roads commission, who then gives the authority for the posting of the structure regarding load and speed. After this is done the inspection and maintenance is under the control of the county commissioners or others, as the case may be, and their attitude toward the proper maintenance of a structure for the load permitted as mentioned above is variable.

## Over 25,000 Inadequate Bridges in Illinois

By G. F. Burch
Bridge Engineer, Division of Highways, Springfield, Ill.

Before the state highway department began operations in 1905, very few highway bridges were built of sufficient strength to carry with safety the loads which were prevalent at that time. Since then, and until quite recent years, many more bridges of insufficient strength or improper design have been erected by local highway authorities who did not see fit to avail themselves of the free service rendered by the state. Since the office of county superintendent of highways was created in 1913, however, the state has had much better control of highway work, and practically all bridges of any size have been designed and built to carry modern traffic.

A bridge survey of the state was made in 1914, through the co-operation of the county superintendents of highways. Figures compiled by the survey indicate that there were then in existence some 41,000 bridges of questionable strength, of span lengths greater than 8 ft. Spans of 8 ft. and less are not considered in this connection because the probability of serious accidents due to structural failure is more remote than for larger structures. Many of these bridges have been replaced with permanent structures, properly designed to carry modern traffic, but because of the many sources from which funds are derived exact figures on the number of replacements are not available. However, an estimate, based on the average length of life of the various types of bridges represented and the funds available for new construction, indicates that approximately 28,000 to 30,000 of these inadequate bridges were still in service at the close of the year 1920.

The highway department has had occasion to investigate the carrying capacity of many of these bridges, and, to date, not one has been found which is strong enough to carry modern highway traffic with safety. Generally, it is found that the truss members will carry a uniform live load of 60 to 70 lb. per square foot of roadway surface; the floor beams will carry a concentrated load of 8 to 10 tons; and the stringers will carry a concentrated load of 4 to 7 tons. Such bridges are not safe for anything heavier than pleasure vehicles and ordinary wagon loads, and it must be remembered that these figures were derived from bridges where there was some question regarding the strength, the majority of investigations being made to determine the advisability of replacing the old plank floor with a new floor of reinforced concrete. At the same time there are undoubtedly many other bridges which, beyond all question, are too weak to carry highway traffic with any degree of safety.

Failure of truss members is of rare occurrence because a uniform live load of sufficient size to develop the full strength of the truss members is less common than heavy concentrated loads which will cause failure of the stringers or floor beams. This fact bears out the figures given above.

The logical conclusion is that the majority of highway bridges which have been in service for ten or fifteen years are unsafe for modern traffic. As extensive repairs are usually not economical, the only solution of the problem is to replace such bridges as rapidly as the funds available will allow. This policy, we believe, is being followed consistently in Illinois.

## Systematic Investigation of Highway Bridges

By W. D. Uhler
Chief Engineer, Pennsylvania State Highway Department, Harrisburg

It is a well known fact that the present condition of many bridges on main trunk highways in this country is far from safe, and I believe that the progress report of the bridge committee of the American Road Builders' Association should be carefully noted by all state organizations with a view toward their carrying on much more detailed investigations of their bridges in a systematic manner, such as Mr. Torkelson's article has elaborated upon.

In any investigation involving the detailed analysis or field investigation of a great number of structures there is a grave chance that the investigation will be undertaken before a proper outline has been prepared. I believe that Mr. Torkelson's description of the Wisconsin method could very readily be adapted to conditions encountered in all states. This phase, as shown both by Mr. Torkelson's and the committee's report, accentuates the need of this systematic outline before proceeding with field work. Field investigations must be handled by men conversant with bridge design, and systematic field inspection must be premised upon the preparation of span diagrams which can quickly and easily be interpreted by the office engineer.

## Bridge Renewal Must Follow Adequate Repairs

By C. J. Bennett
State Highway Commissioner, Hartford, Conn.

I thoroughly agree with Mr. Torkelson that what we need to do is to take better care of our bridges by moderate-priced repairs. We are prone to look at a bridge as being useless when it is of poor appearance or of some age. I have long been of the opinion that we should pay more attention to the smoothness of highway bridge floors in order to reduce the impact. We must, however, realize that our bridges are not up to the demands of modern traffic, particularly here in the East, and on the side roads.

There is no foretelling just where it may be desired to operate a 5-ton truck. There are countless bridges, on the back roads in this state at least, which are dangerous when subjected to a fully loaded 5-ton truck, especially when impact is taken into consideration. Generally, the approaches to these bridges are rough, and the vehicle strikes the floor of the bridge in such a manner as to cause serious impact. Many of these bridges are of timber and have not been kept in proper repair, due particularly to the fact that the small towns have not sufficient funds to make the necessary improvements. While I do not think that 80 per cent of all bridges come under this category, certainly there are a large number.

Furthermore, we have many bridges which, while sufficiently strong to carry the necessary loads, are not of adequate width to permit of the passage of two vehicles. This difficulty is a serious one, particularly at night, so that the bridge problem in this section of the country

is not particularly easy of solution. A reasonable plan should be worked out so that our bridges may be improved and replaced as rapidly as possible, but meanwhile adequate repairs should be provided for, so that disaster may not ensue.

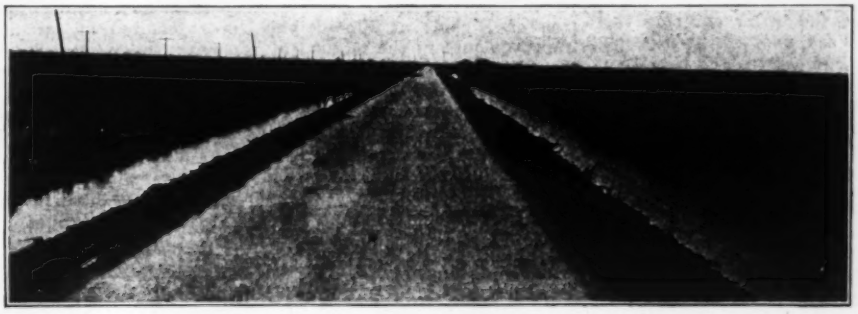
Most failures are floor failures. It is very seldom that a load sufficiently heavy to rupture the truss will be carried by the floor. As a matter of fact, bridge failures of serious nature are comparatively few, although there are many bridges which should fail under the loads to which they are subjected. The writer is of the opinion that these bridges stand up merely from force of habit.

# Concrete Pavement on a Saturated Adobe Foundation

## Large Drainage Ditches and Gravel Subbase to Meet Special Requirements in California Rice Growing District

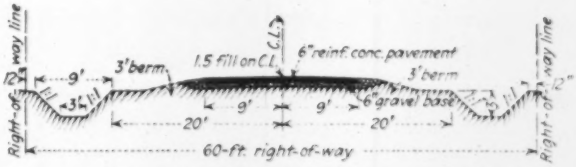
By T. E. Stanton
Assistant Highway Engineer, California Highway Commission

In recent years rice culture in the Sacramento Valley has introduced highway problems new to California. In many of the rice districts there is a preponderance of adobe soil, and on this the rice growers put an average of 8 ft. of water between May and October. In the early stages of the rice industry the rice growers gave very little attention to drainage, so that the ground under the roads, which were subjected to excessively heavy truck haul from the rice fields, was in a state of heavy saturation. Under these conditions there has been practically complete failure on three or four miles of 4-in. concrete base and partial failure of at least ten miles more. These roads were constructed prior to the advent of the rice industry. One of the problems before the Highway Commission therefore has been to build a type of road that would give satisfactory service under the conditions obtaining in these districts. A specific instance of how this problem is being solved is described in the following.



PAVED ROAD BEFORE VENTING DRAINAGE DITCHES

Bids for grading a section of the highway between Biggs and Nelson in Butte County (in the rice growing district) were called for in November, 1917, and again in June, 1918, without getting any response from contractors. It was felt that this lack of interest was at least partly due to previous failures of concrete pavement in the rice district, and the current belief that saturated adobe subgrade and the possibility of alkali in the drainage water would call for special methods on the Butte county work.




CROSS-SECTION OF ROAD IN RICE DISTRICT

Work was accordingly started by the highway commission on the day labor plan in the latter part of 1918. It was soon found that at this time of year it would be impossible to handle the water-soaked adobe with teams and fresnos. A ditching machine was therefore sent to the job with which a ditch was excavated on each side of the highway, 3 ft. deep and 3 ft. wide on the bottom, with 1 to 1 slopes, making a top width of 9 ft. Excavated material was deposited in the center of the roadway, leaving a 3-ft. berm between the toe of the roadway slope and the edge of the ditch. The outer edge of each ditch was kept within one foot of the 60-ft. right-of-way line and the material from both ditches was used to raise the level of the ground between them.

Wherever possible the roadside ditches were provided with outlets into main drainage ditches excavated by the land owners. Although it has not been possible to provide outlets at all the desired points, and seepage water is standing in the ditches part of the way, yet endeavor is being made to provide enough outlets to keep the entire length of roadside ditches free from standing water.

When the excavated material deposited on the roadway had drained and dried out sufficiently fresno and grader teams were put on and it was worked down to the desired grade. On the grade thus built, and for a width of 22 ft., there was spread 6 in. of gravel which was worked into the comparatively soft adobe subgrade to a considerable extent by traffic and was then rolled and thoroughly compacted. A 6-in. layer of 1:2:4 concrete, 18 ft. wide, was then spread, reinforced with ⅝-in. square rods, laid across the roadway on 18-in. centers, and a ½-in. rod was laid along each edge.

Of the twelve and a half miles of road built on this job six and a half miles were through the adobe formation which had been planted to rice and which required the special construction provisions described. Although alkali was undoubtedly a contributory cause in the failure of several miles of concrete pavement in Glenn County, which traversed a district in many respects resembling that described in the foregoing, no alkali was found on the Butte county job and no special provisions for it were therefore considered necessary.

## Ask for New Point Bridge

Investigation of the condition of the Point Bridge by the city council has been requested by the Chamber of Commerce of Pittsburgh. A committee report of the chamber sets forth that the bridge is not strong enough to bear the heavy trucks being hauled over it, is dangerous, and should be rebuilt.

# Results of 15 Years' Operation of the Indianapolis Filters

## Rates of Filtration Have Been Doubled Maintaining Efficient Bacterial Removal and Reducing Unit Costs

SINCE 1904 when the Indianapolis slow sand filters were put into operation little or no information as to results has been given the public by the Indianapolis Water Co. A paper by H. E. Jordan, superintendent of filtration, was presented by title to the Indiana Sanitary and Water Supply Association at its 1920 convention but it has been completed only recently for inclusion in the proceedings. The paper is replete with tables and extended discussions of the reasons for the progressive steps from large plain uncovered low rate sand filters for a raw water averaging 40 p.p.m. turbidity to the present smaller covered units operating at more than double the originally designed rate on a water pre-treated with coagulant and two days settling plus treatment for algæ in summer. The first five years' operation, which consisted of filtration and laboratory control only, cost $5.28 per million gallons. The five years' operation, ending Dec. 31, 1919, included additional charges for pre-treatment and sterilization, but the cost was only $4.50.

Details of the maintenance of the sand layer, the essential item in slow sand filter operation, are described by Mr. Jordan as follows:

In the years preceding the adoption of the pre-treatment process the average number of days a filter would run before it needed cleaning approximated 25 and the average output per acre of sand surface 62,500,000 gal. At the close of these runs the removal of sand necessary to place the unit in satisfactory operating condition for the succeeding run averaged 2.6 cu.yd. per million gallons of water produced. The improvement in the quality of the water entering the filters has been manifest during the past five years by an increase in the number of days run between cleanings to 42.8 and an average million gallons produced between cleanings of from 135 in 1915 to 247.2 per acre in 1919, and whereas the average running rate per day in 1906, 1907 and 1908 averaged 2.5, the running rates in 1916 and 1917 was 5,000,000 gal. per acre per day and in 1919, 5,940,000 gal. At the same time the necessity of removing 2.5 yd. of sand per million gallons of water filtered, has been reduced to approximately 1 yd. in 1913-14-15 and 0.705 yd. in 1919. These results of the improved character of the water entering the filters are of course intimately correlated. The reduction in the amount of sand handled per yard is directly proportional to the amount of material which the filter is compelled to remove and the conditions of this material as to the ability of the filter to remove it immediately at the sand surface or fractions of an inch below. The reduction in the amount of sand removed also obviously reduces the amount of time which the filter must remain out of service for cleaning and sand restoring purposes. The reduction in this amount of lost time then increases the available running time of the unit and the total output of the plant.

*Sand Handling and Cleaning Methods*—The methods in use in handling sand have materially aided the increased production of water. When the plant was first put in service material was placed in the filters by hand, using wheelbarrows, and the soiled material was removed in the same fashion. The first improvement in sand handling methods was the adoption of the sand ejector for removing material from the filter, but clean sand was still replaced by wheeling ing. Next the wheeling-in method was discarded and the material was washed back into the filter from the ejector into a double box arrangement from which the sand, first drained of its carrying water, was thrown by hand into place in the filter. There was, about 1908, in use in Washington what is known as the washing-in method of sand restoration; that is, carrying above the filter surface a hose of water approximately the depth to which it was desired to restore sand, returning the sand to the filter with the ejector and allowing it to flow from an open end of the hose suspended at the end of the boat, into the water where it fell to the sand surface and piled up to the height desired. While this method was used for several years at the Indianapolis plant, it was discarded because of the fact that it did not seem possible to avoid the formation of a silt layer at the point where the old and new sand layers joined and at the same time to bring about a decided stratification of the sand dependent upon the relative specific gravity of the various grain components of the total sand layer. In 1914 a modification of the Nichols washing-in-place method was adopted and still is used.

The original method, with labor costing from 12½c. to 15c. an hour, involved the expenditure of $1.25 per yard of material handled for removal, washing and replacing. The use of the stilling box instead of the wheeling-in reduced the cost to $1 per yard. Various improvements in the sand handling capacity of ejectors used and the washing-in method of restoring reduced the cost until in 1911 and 1912 the total expenditure was 40.5c. per cubic yard for scraping, ejecting, washing, replacing and smoothing sand. Adoption of the washing-in-place method eliminated an additional handling of sand outside the filter unit and with labor at 22½c. an hour made the total cost of sand handling 25c. a cubic yard in 1917. In 1919, with labor at 40c. instead of 22½c., and decreased efficiency of the laborers, the cost increased to 55c.

Remembering the fundamental proposition that sand handling is the key to the successful operation of the slow sand filtration plant, it becomes increasingly a matter of displeasure to the writer to confess the relatively small mechanical improvements which have been made in this operation. The Pittsburgh plant installed equipment built by the Blaisdell Manufacturing Co. for removing and restoring sand. Likewise Wilmington, Del., constructed its filtration plant in such a way as to accommodate the Blaisdell washing-in-place machine. Later developments under the direction of Nichols at Philadelphia have resulted in certain improvements in the method of removing soiled sand from the filter. It still remains necessary, however, under the present condition of labor shortage and inefficiency to attempt to increase in every way possible the mechanical methods of handling sand and the chief thing to be desired in the operation of a slow sand plant is a piece of equipment—relatively light and easily movable—which will remove soiled sand, wash it and replace it in the sand layer.

False information obtained by turbidity averages is no more clearly shown than by the Indianapolis experience. For 56.1 per cent of the time the turbidity of White River is less than 30 p.p.m. and for the whole period of record the average is below 40. Only 18.6 per cent of the time does it exceed 50 p.p.m. On only 2.7 per cent of the days during the entire life of the plant has the turbidity exceeded 200 p.p.m. Yet the operating data indicates beyond question the cumulative effect of handling without preliminary treatment the excess turbidity in so small a percentage of days. To resume the quotation from the report:

The days of the year during which coagulant was applied to the raw water have varied from 149 to 225, and the average pounds per million of coagulant used ranged from 118 to 275.

It was the opinion when pre-treatment was first decided upon that lime-and-iron treatment would be applicable to the local situation. This opinion was furthered by the conspicuous success of two plants nearby which operated with raw water having high turbidity. Experience showed that White River water on very few days in the year carries such character and quantity of suspended material as to make this method satisfactory, and on a great many days of the year a relatively slightly turbid water (and this

turbidity largely colloidal) is not satisfactorily treated except with sulphate of alumina.

In very condensed form the range of raw water turbidity and rate of coagulant required may be expressed as follows:

RAW WATER TURBIDITY AND COAGULANT USED

| Range | Total Test Days 1904-1919 | Per cent of Time | Pounds per m g Alum Used |
|---|---|---|---|
| 0- 10 | 1,154 | 20 7 | ..... |
| 11- 20 | 1,044 | 18 8 | ..... |
| 21- 30 | 926 | 16 6 | ..... |
| 31- 40 | 898 | 16 1 | 65 |
| 41- 50 | 514 | 9 2 | 95 |
| 51-100 | 618 | 11 1 | 180 |
| 101-150 | 170 | 3 0 | 285 |
| 151-200 | 98 | 1 8 | 370 |
| Over 200 | 150 | 2 7 | 450 |

*Bacterial Results*—Daily examinations of the plant effluent with incubation at 20 deg. C. were carried on from the beginning of the operation of the laboratory. Counts at 37 deg. C. were not made continuously until 1912. From that date until the present time an analysis of the figures indicates that 43.5 per cent of the time the 37 deg. C. count is less than 5 per c.c., 33.5 per cent of the time from 6 to 10; 17 per cent of the time from 11 to 20; 2.9 per cent of the time from 21 to 30; 3.8 per cent of the time from 30 to 100; with one day since the beginning of the 37 deg. C. counts a bacterial content of the filter plant effluent in excess of 100 per c.c. The average by years has ranged from 5 per c.c. in 1916 to 12 in 1912. Studying the quality of the finished water as referred to the presence of B. coli, during 74.5 per cent of the time no B. coli were found in 100 c.c. of the effluent; 17.9 per cent of the time 1 or 2 B. coli per 100 c.c. were present; 3.5 per cent of the time 3, 4 or 5 per 100 c.c.; 3.3 per cent of the time from 6 to 10 inclusive, and for 0.52 per cent of the time more than 10. The average B. coli content per 100 c.c. of the filter plant effluent was 0.85.

### Typhoid Reduction

Previous to this installation of the filtration plant, the typhoid death rate was high, reaching epidemic conditions in 1893, 1895 and 1904. The average for all years of record was 51.8.

After the plant was placed in operation, the reduction in rates proceeded slowly, but finally to a very satisfactory rate in 1918 and 1919. In 1916 there was a decided rise in typhoid deaths, summer typhoid associated with swimming in polluted streams. The general average typhoid rate since 1905 ha sbeen 22, a reduction to 43 per cent of the pre-filtration days.

In 1904, when there was an investigation of the water supply and general sanitary conditions in Indianapolis, in addition to recognizing the necessity of completing the filtration plant already under construction it was recommended that the large number of private wells and unsanitary privies be eliminated. Repeatedly since that time various individuals have urged that the same action be taken, but no result has been obtained.

Studies of typhoid cases over a period of years locates over 80 per cent of the total as occurring where a private well or privy or both are used. If Indianapolis performed its duty in improving sanitary conditions as well as the Indianapolis Water Co. has fulfilled its duty to the public the typhoid death rate would be less than 1 per 100,000.

Mr. Jordan summarizes the results of the operation of this modified slow sand filter from the standpoint of quality and cost of operation as follows.

The prime requirement of successful operation of slow sand filters is a proper condition of the sand layer. Operating in favor of this is the increased size of the particles applied in a pre-treated water, as well as reduced total suspended matter. Operating against the condition of the sand layer are two main factors. The first is the summer increase in micro-organisms which is a far more important factor in water purification in the Central West than is generally recognized. Algæ and other micro-organisms interfere with satisfactory operation of rapid sand filters. The second is air-binding, which may manifest itself in a spongy consistency of the sand layer quite comparable to quicksand when the water is drained off. It is also evidenced by small craters or rosettes of sand, scattered indiscriminately over the surface where the air has gathered in large particles and forced its way to the surface. This problem has been the source of very serious difficulties, notably at the Wilmington, Del., plant, and represents at the present time one difficult factor in the operation of all plants, but notably in slow sand units during cold weather.

The operation of slow sand filter plants, while it has extended over a great many years, has not been the subject of such careful study in this country as have the operations of mechanical filter plants. The best summary of the basic rules of slow sand filtration of water was made by George W. Fuller at the Lawrence Experiment Station at Lawrence, Mass., in 1894. These fundamentals may be re-stated briefly as follows:

1. Bacterial efficiency of slow sand filters increases with age, other conditions being equal.

2. New filter sand is quite unlike that taken from filters which have been in operation for some time. The grains of the latter are covered with a sticky coating; in the case of grains situated at or just below the upper surface layer of sand this coating is so thick that the grains are considerably discolored. Here it is that the applied bacteria are detained in the largest numbers.

3. In new filters, and in old filters which have been out of operation for a considerable period, normal bacterial results do not appear to be obtained until these films are formed.

4. In old filters which are in regular operation, and which yield normal chemical and bacterial results, a marked deterioration in these results occurs when for any reason there is a well-defined mechanical disturbance of the main body of sand, whereby the continuity of the films is broken to a certain degree.

5. Low rates are undoubtedly safer than high rates; but, nevertheless, up to a certain limit the rate apparently exerts very little influence, and this limit is different for different filters and varies with other conditions in the case of the same filter.

6. With our present knowledge it may be stated that the factor which causes the effect of the rate of filtration upon bacterial efficiency to become practically nil, under normal conditions, is chiefly the age of the filter.

In the operation of the Indianapolis plant, the studies made during the fifteen years makes it possible to add to these observations the following:

The pre-treatment by coagulant of a water supplied to slow sand filters results in the grouping together of the suspended particles in fairly large aggregates which are a substitute in a measure for the sticky coating of the surface layer. The bacterial content of a sand layer filtering pre-treated water is not so high in total numbers nor so active as in the case of a filter handling untreated influent.

The bacterial efficiency of filters operating in this fashion is less than that of filters operating with an untreated influent. The removal of organic material from the water to be filtered lessens the supply of material to be deposited in the filters, and at the same time interferes with certain biological processes which are more active in the plain type.

Slow sand filters operating with a pre-treated water are more susceptible to seasonal variations of bacterial flora, both in the influent water and in the sand layer, and may at times unload somewhat in the fashion of sewage filters. This unloading process has no relation to the quality of raw water and with a sterilization treatment following is not apparent in the finished product.

Shutting off units and allowing them to stand for twenty-four to forty-eight hours does not seem to interfere with efficiency. Continued suspension, however, for a week or more seems to result in the deposition of material within the upper sand layer which materially reduces the production of the filter unit during the ensuing run.

Variations in depth of sand layer from 8 to 30 in. have been permitted at the local plant, and the results of operation indicate that the thinner layers give no less satisfactory purification. In point of ease of handling the filter unit, the thinner layer is preferable.

# Superelevated Curve Practice on Minnesota Highways

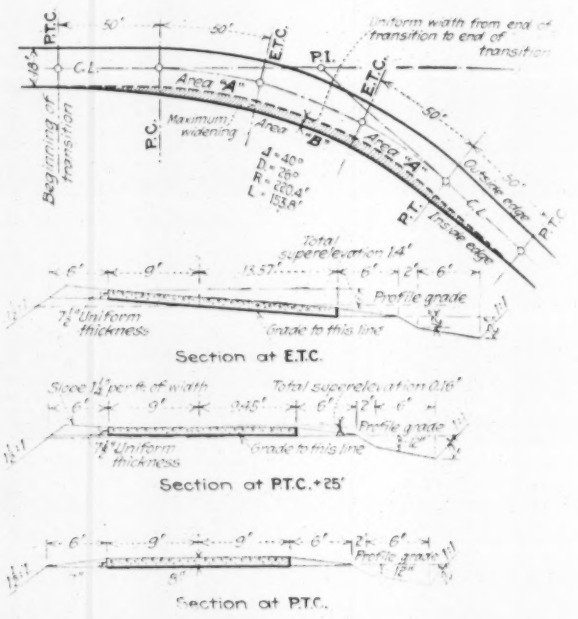
PRACTICE in widening and superelevating highway curves has been standardized in Minnesota by adopting a ring method of widening and by setting speed and curve limits for superelevation. This action, with the preparation of suitable charts, has simplified field work and office computation, particularly in determining additional area due to widening.

Referring to the drawing it will be seen that the widening is uniform between two transition curves to the tangents. By adopting a uniform length of transition and calculating offsets and areas as in the table the area of extra pavement required is quickly computed.

Taking the curve illustrated as an example the procedure is: From the table, under area in square yards for two transition curves and 18 ft. width of pavement, opposite 26 degrees, the sum of the areas $A$ and $A$ is obtained and is 48.819 sq.yd. From the same table under area in square yards per 100 lin. ft. and 18 ft. width of pavement, opposite 26 degrees, is obtained the figure 48.178. The product of this figure and $\frac{L}{100}$ is the area $B$, or $48.178 \times \frac{153.8}{100} = 25.919$ sq.yd. The area of extra pavement required by widening is, therefore, 48.819 + 25.919 = 74.74 sq.yd.

Study of conditions by the department engineers decided them to specify that for curves from 2 deg. to 7 deg. the pavement should be superelevated to compensate for a speed of 27 mi. per hour, the maximum superelevation being ½-in. per foot of width. The maximum superelevation adopted for curves from 7 to 29 deg. compensates for speeds decreasing uniformly from 27 mi. to 12 mi. per hour. After the maximum superelevation is reached at 7 deg. the pavement is given a graduated additional widening commencing with 2 ft. for 8 deg. and increasing uniformly to 5 ft. for 29 deg.

Supplemented by a tabulation of superelevation pitches per foot width, the illustration and table enable precise and quick office calculation and field location of widened and superelevated curves. Information concerning the method was furnished by O. L. Kipp, construction engineer, Minnesota Highway Department, St. Paul, Minn.




PLAN AND SECTIONS OF CURVE, SHOWING METHOD OF WIDENING

TABLE I—OFFSETS AND AREAS FOR EXTRA WIDENING OF CURVES ON PAVEMENT

| Dist. from P. T. C. | Perpendicular Offset from Inner Edge of Pavement on Tangent | | | | Radial Offset from Inner Edge of Pavement on Curve | | | | | | Area Sq. Yd. for Two Transition Curves | | Area Sq. Yd. Per 100 Lin. Ft. of Curve for Extra Pavement | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Width of Pavement | | | |
| Degrees D | Ft. 10 | Ft. 20 | Ft. 30 | Ft. 40 | Ft. 50 | Ft. 60 | Ft. 70 | Ft. 80 | Ft. 90 | Ft. 100 | Ft. 18 | Ft. 20 | Ft. 18 | Ft. 20 |
| 8 | 0.03 | 0.16 | 0.37 | 0.64 | 0.99 | 1.33 | 1.62 | 1.83 | 1.97 | 2.00 | 21.858 | 21.833 | 21.912 | 21.881 |
| 9 | 0.03 | 0.17 | 0.39 | 0.68 | 1.06 | 1.43 | 1.74 | 1.97 | 2.11 | 2.14 | 23.395 | 23.361 | 23.402 | 23.364 |
| 10 | 0.03 | 0.17 | 0.40 | 0.72 | 1.13 | 1.54 | 1.87 | 2.11 | 2.25 | 2.29 | 24.927 | 24.889 | 24.994 | 24.950 |
| 11 | 0.03 | 0.18 | 0.42 | 0.76 | 1.20 | 1.64 | 1.99 | 2.24 | 2.39 | 2.43 | 26.462 | 26.418 | 26.471 | 26.419 |
| 12 | 0.04 | 0.18 | 0.44 | 0.80 | 1.27 | 1.74 | 2.12 | 2.38 | 2.54 | 2.57 | 27.996 | 27.946 | 27.948 | 27.881 |
| 13 | 0.04 | 0.19 | 0.46 | 0.84 | 1.34 | 1.85 | 2.24 | 2.52 | 2.68 | 2.72 | 29.531 | 29.474 | 29.512 | 29.443 |
| 14 | 0.04 | 0.19 | 0.47 | 0.88 | 1.42 | 1.95 | 2.37 | 2.66 | 2.82 | 2.86 | 31.037 | 30.972 | 30.968 | 30.890 |
| 15 | 0.04 | 0.20 | 0.49 | 0.92 | 1.49 | 2.05 | 2.49 | 2.79 | 2.96 | 3.00 | 32.543 | 32.470 | 32.417 | 32.330 |
| 16 | 0.04 | 0.20 | 0.51 | 0.96 | 1.56 | 2.16 | 2.62 | 2.93 | 3.10 | 3.14 | 34.050 | 33.967 | 33.859 | 33.762 |
| 17 | 0.04 | 0.21 | 0.52 | 1.00 | 1.63 | 2.26 | 2.74 | 3.07 | 3.24 | 2.29 | 35.556 | 35.464 | 35.401 | 35.295 |
| 18 | 0.05 | 0.21 | 0.54 | 1.04 | 1.70 | 2.36 | 2.87 | 3.21 | 3.38 | 3.43 | 37.062 | 36.962 | 36.828 | 36.709 |
| 19 | 0.05 | 0.22 | 0.56 | 1.07 | 1.77 | 2.47 | 2.99 | 3.34 | 3.52 | 3.57 | 38.534 | 38.422 | 38.248 | 38.117 |
| 20 | 0.05 | 0.22 | 0.58 | 1.11 | 1.84 | 2.57 | 3.12 | 3.48 | 3.67 | 3.72 | 40.006 | 39.884 | 39.767 | 39.622 |
| 21 | 0.05 | 0.23 | 0.59 | 1.15 | 1.91 | 2.67 | 3.24 | 3.62 | 3.81 | 3.86 | 41.478 | 41.344 | 41.171 | 41.014 |
| 22 | 0.05 | 0.23 | 0.61 | 1.19 | 1.98 | 2.78 | 3.37 | 3.76 | 3.95 | 4.00 | 42.950 | 42.805 | 42.567 | 42.397 |
| 23 | 0.05 | 0.24 | 0.63 | 1.23 | 2.05 | 2.88 | 3.49 | 3.89 | 4.09 | 4.14 | 44.422 | 44.266 | 43.956 | 43.771 |
| 24 | 0.06 | 0.24 | 0.64 | 1.27 | 2.12 | 2.98 | 3.62 | 4.03 | 4.23 | 4.29 | 45.888 | 45.718 | 45.441 | 45.241 |
| 25 | 0.06 | 0.25 | 0.66 | 1.31 | 2.20 | 3.09 | 3.74 | 4.17 | 4.37 | 4.43 | 47.353 | 47.170 | 46.814 | 46.599 |
| 26 | 0.06 | 0.25 | 0.68 | 1.35 | 2.27 | 3.19 | 3.86 | 4.31 | 4.52 | 4.57 | 48.819 | 48.622 | 48.178 | 47.947 |
| 27 | 0.06 | 0.26 | 0.69 | 1.39 | 2.34 | 3.29 | 3.99 | 4.44 | 4.66 | 4.72 | 50.284 | 50.074 | 49.637 | 49.390 |
| 28 | 0.06 | 0.26 | 0.71 | 1.43 | 2.41 | 3.40 | 4.11 | 4.58 | 4.80 | 4.86 | 51.750 | 51.526 | 50.984 | 50.720 |
| 29 | 0.06 | 0.27 | 0.73 | 1.47 | 2.48 | 3.50 | 4.24 | 4.72 | 4.94 | 5.00 | 53.216 | 52.978 | 52.322 | 52.041 |

## Science and Research Bodies to Have New Home in Washington

A home for the National Academy of Sciences and the National Research Council is to be built in Washington. Donations from a number of friends of the two organizations have enabled them to purchase the block bounded by B and C Sts. and 21st and 22d Sts. N. W., facing the Lincoln Memorial in Potomac Park. The cost was about $200,000. The Carnegie Corporation will defray the cost of the building itself. The donors of funds for the land purchase include Ambrose Swasey, E. A. Deeds, Charles F. Kettering, Henry Ford, George Eastman, Adolph Lomb, Charles F. Brush, P. S. du Pont and the Corning Glass Works.

# Sewage-Works for Lincoln, Nebraska and Suburban Towns

SETTLING tanks of the separate digestion type, to which sewage is pumped from a receiving basin and from which the effluent passes to sprinkling filters, constitute the main element of sewage-works recommended to serve a sanitary district comprising the city of Lincoln, Neb., and four suburban towns, the amount of sewage having become too great for adequate dilution in Salt Creek. This plant will treat all the sewage discharged above the works at 27th St. and for about ten years there will be ample dilution for sewage entering below that point. When this latter sewage increases to such an extent as to cause a nuisance, settling tanks may be constructed for the two suburban towns of Havelock and University Place, to be supplemented later by sprinkling filters if necessary. The above statement is summarized from a recent report by Alvord & Burdick, consulting engineers, Chicago, on the proposed sanitary district.

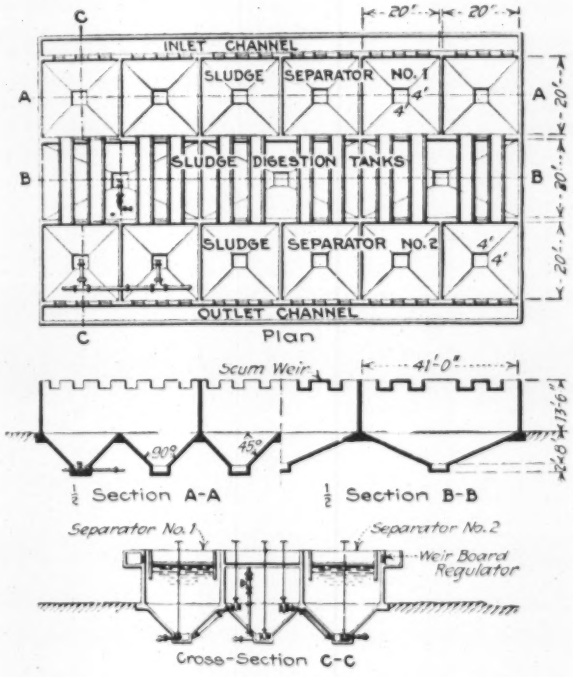



FIG. 1. SETTLING TANKS AND SLUDGE CHAMBER

Lincoln and the four suburban towns have a population of 70,000 and more than 100 miles of sewers on the separate system. With the extensions to be built this year nearly 100 per cent of the population will be served. The daily sewerage discharge of the entire district is about 4,500,000 gal., nearly 80 per cent of this being from the city of Lincoln. It is estimated that by 1950 the population will be 175,000, the daily sewage discharge 13,000,000 gal., and the area increased from 8,000 to 23,000 acres by extending the city limits.

The sewage is typically domestic and varies from fresh to a maximum age of five hours. Salt Creek has a minimum flow of 50 sec.-ft. and during a considerable part of the year it is a nuisance owing to odors and deposits. The principal requirements for the effluent of the sewage-works are that it must be stable and odorless and reasonably free from suspended matter, particularly coarse material. It is considered that further refinements, if involving additional expense, are not warranted.

To abate the present nuisance, an intercepting sewer

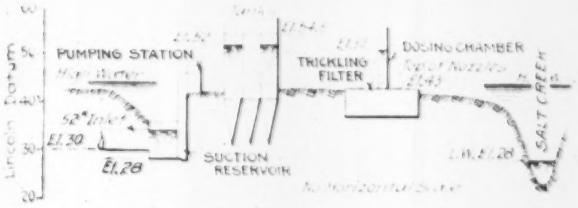



FIG. 2. DIAGRAMMATIC SECTION OF SEWAGE-WORKS

is being built parallel with the creek and will be extended to the new plant. As all sewage will have to be pumped to give a gravity flow through the plant, the interceptor will discharge into a 125,000-gal. two-compartment reservoir to supply the pumps, which will be driven by electric motors and controlled automatically by floats. This interceptor is designed with sufficient capacity for 1950 conditions, but the sewage-works are designed for the conditions of 1930, with a population of 100,000, in order to allow for possible development in methods of sewage treatment. A diagrammatic section through the plant is shown in Fig. 2.

The type of tank proposed is adapted particularly for such conditions as those at Lincoln, where the sewage is domestic and relatively fresh and will form considerable quantities of both sludge and scum. This type was designed first by Mr. Alvord for the plant at Madison, Wis. (see *Engineering News-Record*, Sept. 11, 1919, p. 510), and was used later for the naval training station at Great Lakes, Ill. As shown in Fig. 1, it includes baffled, hopper-bottom primary and secondary compartments separated by a sludge digestion chamber, each compartment being connected to this chamber by sludge pipes and scum weirs. Each of the six tanks will have a working capacity of 1,000,000 gal. daily, with a detention of 45 minutes in each compartment. This total detention period of 1½ hours is sufficient for reduction of about 75 per cent of the solids, but is not so long as to make the sewage too stale for economical subsequent treatment.

From the tanks, the sewage will flow to dosing chambers in circular sprinkling filters 375 ft. in diameter, two of which will be sufficient for conditions up to 1930, when the tank effluent will be at the rate of about 4,500,000 gal. daily. The beds will be 6 ft. deep, filled with broken stone ranging from 3-in. size at the bottom to ½-in. at the top. They will be equipped with cast-iron distributors and risers having nozzles spaced 12 ft. c. to c. Secondary sedimentation is believed unnecessary in view of the amount of dilution available. It is pointed out that the filter effluent will carry practically the same amount of suspended matter as the tank effluent, or 20 per cent of that in the raw sewage, but that these solids will be finely divided and as stable as the effluent.

The recommended plans of the engineers have been adopted, and the city will extend the intercepting sewer to the plant at an estimated cost of $140,000. This will be done under the direction of George W. Bates, city engineer. As the city and four independent suburban towns will be served the sanitary district already

mentioned has been organized to build and operate the works. The cost for a plant sufficient for 1930 conditions is estimated at $330,000, with an annual operating cost of $12,500.

Three other disposal methods were considered, but the operating costs were considerably higher, although the activated-sludge process gave a lower construction cost. For tanks and sand filters the estimated construction cost was $525,800 and the annual operating cost $15,400. With the activated-sludge process preceded by tank treatment the construction cost would be $250,000, and for an activated-sludge alone it would be $212,000. The corresponding annual operating costs would be $44,800 and $77,700, as compared with $12,500 for the plant as adopted. Fixed charges are not considered in any of the estimates.

## Averages and Maximum Runs in Concrete Paving

### Relation Shown by Graphs of Sixteen Minnesota Paving Operations—Maximum Record Outfits Described

AVERAGE speeds per working day in placing concrete road slab were about half the speed recorded by the maximum day's run during any month's operation in 1920 on sixteen paving contracts in Minnesota. Ordinarily the maximum day's run, when it was extraordinary, exceeded greatly that of any other day. However, operations which exhibited an extraordinary day's performance also showed high averages both for the month and the season.

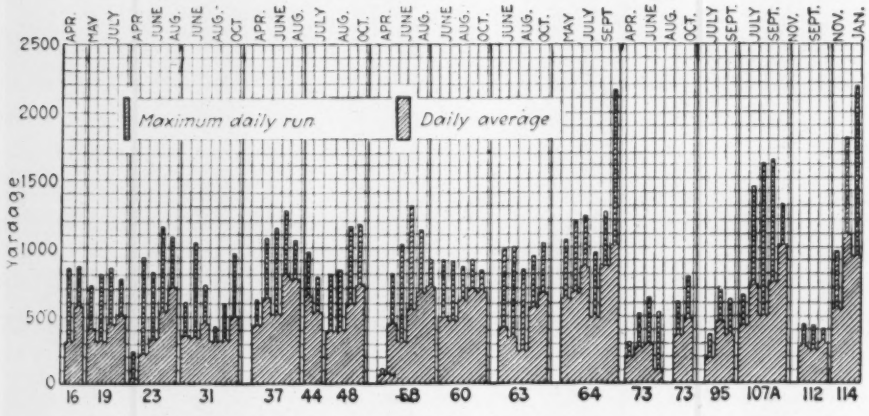

APR. MAY JULY APR JUNE AUG. JUNE AUG. OCT APR. JUNE AUG. JULY AUG. OCT. APR. JUNE AUG. JUNE AUG. OCT. JUNE AUG. OCT. MAY JULY SEPT APR. JUNE AUG. OCT. JULY SEPT. JULY SEPT. NOV. SEPT. NOV. JAN.
2500
2000
1500
1000
500
0
Yardage
Maximum daily run
Daily average
16 19 23 31 37 44 48 58 60 63 64 73 73 95 107A 112 114

FIG. 1. DAILY AVERAGE AND MAXIMUM DAY'S RUN FOR EACH MONTH ON SIXTEEN PAVING OPERATIONS

Besides the facts noted, the graph by months of the season's operations indicates peak performances perhaps never surpassed in concrete pavement construction. The high records were on operations 64 and 114 and in both, 18 ft. one-course concrete slab, 7½ in thick, was being constructed. On the basis of 2 sq.yd. per lineal foot of pavement the maximum day's run of completed pavement was 1,072.6 ft. on operation 64, and 1,098 ft. on operation 114. The nearest equal record to these Minnesota performances, reported in 1920, was 1,034 ft. of 18-ft. slab, 8 in. thick, laid in one 10-hour day in Michigan.

With the background of averages given by the diagram, peak performances are presented in their proper relation to construction progress. The two, which have been enumerated, command especial attention because of the extreme height of the pinnacle reached.

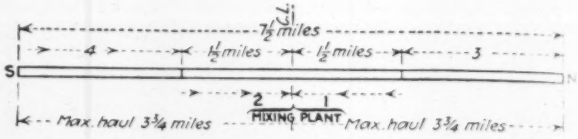



FIG. 2. PAVING PLAN DEVISED TO REDUCE EARTH ROAD HAUL

*2,196 Sq.Yd. in Less than 10 Hr.*—Operation 114, which exhibited the best performance, covers two full months and 13 days in August. Exceptional speed was attained continuously after the preliminary adjustment period—the average, as read from the diagram, was over 1,000 sq.yd. per working day for two months. The peak run of 2,196 sq.yd., it is stated, was made in less than ten hours, lack of cement compelling work to be stopped at 4 p.m.

A flat country was traversed by the road, which was 7½ miles long, paved 18 ft. wide with a 6½ and 7½-in. slab of 1–2–4 stone concrete. In Minnesota, when machine finishing is employed, a 1–2–4 concrete with 2-in. slump is specified. For hand finishing a wet mixture, 6-in. slump, is allowed but the proportion of coarse aggregate is reduced to 3½ parts.

A central mixing plant was adopted by the contractor, with wet batch haulage in 2½-ton motor trucks equipped with 2-cu.yd. Lee bodies for end dumping. The mixing plant was located about midway of the 7½-mile road, and paving proceeded as indicated by the numerals and arrow heads, Fig. 2. With sections 1 and 2 paved, the contractor had 1½ miles of paved road over which to haul in paving sections 3 and 4. Reduction of earth road haul, these roads being very soft in wet weather, was effected by this plan as follows: With a maximum haul of 3¾ miles, the maximum earth road haul was 2 miles, the maximum average was 1 mile and the average was ½ mile. At the mixing plant, sand was hauled 1¾ miles by motor trucks to a ground hopper from which a belt conveyor carried it to the mixer sand bin. Another belt conveyor from the cement house to the mixer floor handled the cement in bags. Stone coming in on gondola cars was unloaded by derrick and clamshell into the mixer stone bin or into stockpile. The 1 cu.yd. mixer, mixing a full minute, discharged into a 2 cu.yd. hopper under which the trucks drove and received their loads averaging 1½ cu.yd. At the pavement the dumped concrete was roughly spread by a horse-drawn scraper and then finished by a finishing machine.

The contractors for this road were McCree, Moos & Co., St. Paul, Minn. Their crew ran from 38 to 51 men.

*2,145 Sq.Yd. in 10 Hr. 21 Min.*—Operation 64, on which the second best performance was made, covered a period of six months. As shown by the diagram, Fig. 1, the peak performance was an isolated one, but

the average for the season was the high one of 880 sq.yd. per working day. On the day of the peak performance, work was begun at 6:15 a.m. and was stopped at 5.35 p.m., with 30 min. for lunch and 30 min. delay due to a breakdown. The average haul of proportioned batches by industrial railway was 2,500 ft. The pavement

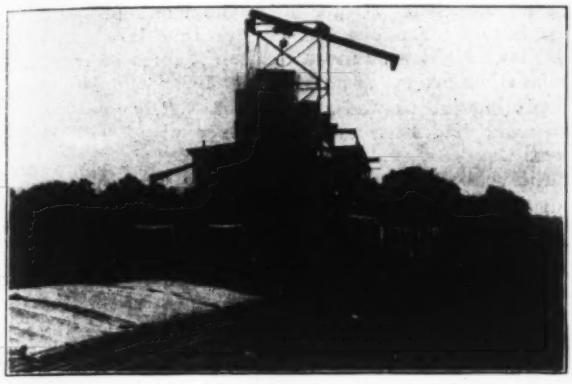


FIG. 3. TRACTOR-HAULED MIXER OUTFIT

dimensions and specifications were the same as in the operation previously described.

In this operation the only features unusual to the normal industrial railway, batch-box haulage method were the use of two finishing machines, one operating about 50 ft. behind the other, and the special mixer outfit illustrated by Fig. 3. A 4-bag paver was mounted on an old steam shovel base and provided with a tower and crane hoist for handling the batch boxes. A steam tractor moved the mixer and supplied steam for it and the hoist engine.

The contractors for this road were Siems, Helmers & Schaffner, St. Paul, Minn. Their crew ran about 66 men, as follows: Overhead 2, materials yard 11, transportation 9, mixer 17, grading and form setting 18, maintenance and repair 6, and miscellaneous 3.

*Conclusions*—Star performances in pavement laying, ordinarily, are either staged ahead or occur because of an exceptional combination of favorable conditions. The perfection of direction, equipment and working crew which enables a peak performance on occasion is generally reflected by unusually good average performances. The old-time contractor's axiom that "stunts don't make estimates," is not as axiomatic as may be thought. It is true that best days' records are about twice average days' records on any job.

## Copper Sulphate for Cleaning Basin Walls

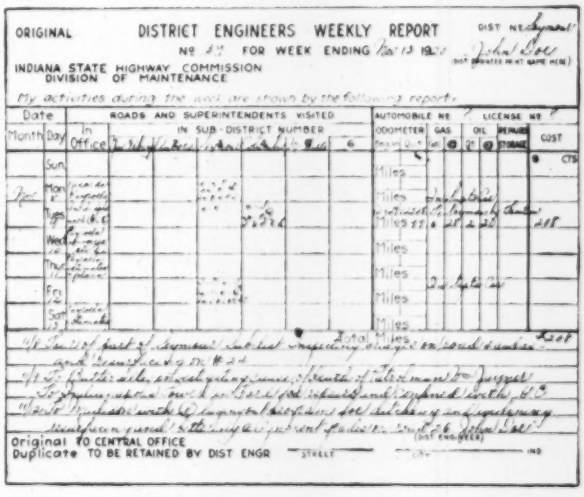
For cleaning algae from the sedimentation basins of the Kansas City water-works at Quindaro, copper sulphate is sprayed on to the surface after lowering the water level a few feet. George F. Gilkinson, chief chemist of the water department, described the methods employed in a paper presented recently before the Iowa section of the American Water-Works Association. Satisfactory results were obtained by spraying the walls to which the algae cling, after drawing down the water, with a paint-spraying pump attached to an 8-gal. keg mounted on wheels. A 5-per cent solution was used. An hour after application the walls are scrubbed with a wire brush and the basin refilled. One gallon covers 125 sq.ft. of wall. Mr. Wilkinson stated that the walls are kept comparatively free from algæ by an application every two months during the summer.

# District Maintenance Engineers' Report Blank

### Daily Activities Recorded on Special Blank and by Map Showing Roads Inspected Each Week

A HELPFUL check is kept on the activities of district engineers of highway maintenance in Indiana by means of a weekly report blank and map. Often it is desired to know more than is told by mileages and expenditures concerning the personal touch which the engineer maintains with his roads and with his assistants. The report blank and the map give this information satisfactorily, both when the chief engineer wishes to determine at a glance whether the district man is covering his job and when he wishes to analyze in detail the distribution of his time by the district man. The map proves valuable for the first purpose.

To bring out clearly the effectiveness of the method an actual report is given, except that names are omitted. The map is printed on the back of the blank form herewith reproduced, the routes of trips made by the district engineer being depicted in colored ink and marked with dates. Symbols are employed to economize space. For example, a section of road is referred to by



ORIGINAL DISTRICT ENGINEERS WEEKLY REPORT DIST No. 4

No. 41 FOR WEEK ENDING Mar 13 1920

INDIANA STATE HIGHWAY COMMISSION
DIVISION OF MAINTENANCE

My activities during the week are shown by the following report.

Date — Month: Mar. — Day: Sun, Mon 8, Tues 9, Wed 10, Thurs 11, Fri 12, Sat 13

ROADS AND SUPERINTENDENTS VISITED IN SUB-DISTRICT NUMBER — In Office; 1 2 3 4 5 6

AUTOMOBILE No. — ODOMETER — GAS — OIL — REPAIRS — COST

LICENSE No.

Original TO CENTRAL OFFICE
Duplicate TO BE RETAINED BY DIST ENGR

DISTRICT MAINTENANCE ENGINEER REPORTS DAILY ACTIVITIES AND EXPENSES

road number and section letter. Employees with whom conference is had are indicated by a number or letter placed within a circle. Thus, referring to the blank, the entry on Monday of *4-P-Q*, followed by the letter *S* in a circle, indicates that on that day the district engineer inspected sections *P* and *Q* of road *No. 4* and consulted with the superintendent of the Seymour subdistrict. Other entries as given are self-explanatory. The map serves merely to indicate graphically the routes and distances covered by inspections.

This blank and map were devised by A. H. Hinkle, chief maintenance engineer, State Highway Commission of Indiana.

## New Jersey Bridges

New Jersey owns 704.2 miles of highways on which exist 568 bridges of over 5-ft. span, 80 per cent of which are incapable of meeting the demands of modern traffic, according to Charles A. Mead, bridge engineer.

# Cost-Plus Contract Successful on Georgia Road Work

By W. R. Neel
State Highway Engineer, Atlanta, Ga.

*Highway construction costs were reduced last year in Georgia by the adoption of a form of cost-plus contract. This contract was devised to moderate bidding prices, which had been progressively increasing, by relieving the contractor from the burden of risk and the expense of financing the work. Its character and the results obtained by its use are summarized here from a paper read at the Washington meeting of the American Association of State Highway Officials.*—Editor.

COMPETITION is not eliminated by a new form of cost-plus contract for highway construction in Georgia. The contractor in submitting his bid divides it into two parts, the estimated cost and the desired compensation. In order to have an incentive to keep down the cost, the contractor is allowed 25 per cent of any saving on the estimated cost, provided it does not exceed 50 per cent of the total compensation in the proposal, and should the cost exceed the estimate, 50 per cent of this excess is deducted from the compensation, with the provision that the compensation must not be reduced more than 75 per cent. Therefore, the contractor is assured of at least 25 per cent of the compensation, as shown in his bid, for which he must furnish at his expense a superintendent and any overhead expense, such as the maintenance of his general office. It is calculated that the 25 per cent will allow the contractor to break even with no loss other than that of his time.

The contract also provides for machinery and equipment rental, a form being provided which must be filled out and which is a part of the contract cost of work. However, the rental schedule is fixed, and only the interest on the value of the equipment is allowed, plus a fair compensation for depreciation, insurance and estimated repairs. In this way no profit can be made other than that shown as compensation, and this amount varies with the skill and zeal used in prosecuting the work.

All cost of the work is paid by the owner. A bonded accountant makes up pay-rolls and supervises the paying of all labor, etc. All materials are purchased by the purchasing agent of the State Highway Department, and the prices for all materials, f.o.b. railroad siding, are included in the proposal. In this way, the only financing required by the contractor is in purchasing equipment, and in paying the salary of his superintendent.

### Practical Results Obtained

This new form of contract has permitted honest contractors of small means to show their ability on a larger scale than would be possible with the old form under which a surety bond is required for the full amount of the contract, which many contractors of small means are unable to make. The facilities for financing this contract have opened a field for intelligent, honest bidders who would otherwise be unable to participate in a project of very great magnitude, except as subcontractors, although their ability might be ample to handle the work.

On a recently completed concrete paving project, the successful bidder could not have financed the project under the old form of contract and yet he has had charge of the construction of more miles of concrete pavement within the state than any other contractor. The result was that 5½ miles of 18-ft. concrete pavement were laid in 3¼ months at a 15 per cent net saving on the contract as awarded. The contractor not only earned his compensation as set forth in his bid, but an additional 50 per cent, the maximum amount permissible. The bid was 24 per cent lass than the next lowest bid which was on the old form of contract. On another project a saving of 11.3 per cent is shown. A grading job showed a saving of 13.2 per cent when the work had been under way for more than three months.

The cost-plus contracts now under way in Georgia amount to over $1,500,000 and a saving of a little over $20,000 has been effected in bond premiums alone, as a minimum bond is required under this form of contract.

## Life of Ties and Timbers in Mexico

UNTREATED pine timber on railways in the coastal plain of Mexico along the Gulf of California has a probable life of only three to four years for ties and six years for trestle timbers, according to a report by J. D. Mathews, engineer of maintenance of way, published in the *Cross Tie Bulletin*. Trestles only nine years old, and which had carried no traffic for five years, owing to the revolutionary troubles, were found rotten and sagging with their own weight.

This condition is due to the extremely rapid decay under the influence of warm and moist atmosphere, a jungle growth of trees and vegetation and an annual rainfall of 30 to 40 in. Creosoted pine had suffered little in nine years. Cedar piles, after the same period, were only approaching the point when renewals would be required. Redwood caps, posts and ties were also in good condition, the ties indicating a minimum life of eight years and a considerably longer average life. Replacement of pine by redwood for ties and all trestle timbers except stringers will be an immediate rather than an ultimate economy under the above conditions, according to Mr. Mathews.

## Studying Power Possibilities on the Tennessee

An engineering and economic survey of the Tennessee River, its tributaries and its basin is being made by the Corps of Engineers, U. S. Army. The survey includes a study of the resources of the basin with the idea of determining the influence of water transportation on their development and the amount of tonnage that they might contribute for transportation by water. The work is being done under a Federal appropriation with co-operative work by the Tennessee River Improvement Association. The mountain areas which fringe the Tennessee Basin are being mapped aërially. One of the important features of the report will be the effect on the main stream by power developments on a non-navigable tributary. This qusetion is a live one because of the many proposed water-power developments. The Parr Shoals dam on the non-navigable Broad River, near Columbia, S.C., so affected the flow of water in the Congaree River as to make navigation impracticable. The Chattahoochee River is navigable to Columbus, Ga. When a large power plant above Columbus finds it necessary to draw out the maximum quantity of water that is uses, boats frequently must be tied up until the needs of the power plant have been supplied.

# Employment Relations in the Construction Industry

AS A GUIDE for the conduct of the future activities of the Associated General Contractors, that organization's committee on labor submitted to the annual meeting held at New Orleans, Jan. 25-27, a constitution of industrial relations supplemented by a statute of employment relations applied to the construction industry, both of which are reprinted below. The committee, which is headed by L. C. Wason, believes that a good deal of difficulty in industrial relations has been caused by confusing fundamental principles with the details of application. The obligations and duties of employer and employee to one another, to capital and to the public have often been mixed in a single document. The committee is of the opinion, therefore, that the separate documents which it has prepared will eliminate, in part, this confusion.

The labor committee's report was approved by the convention.

## Fundamental Principles of Industrial Employment Relations

*Preamble*—Employment relations should accord with and express ideals of justice, equality, and individual liberty. The terms of employment should conform to the essential requirements of economic law and should, through intelligent co-operation, based on a recognition of mutuality of interest, conduce to high productive efficiency. They should reflect an effort to realize ideals of individual and social betterment.

The interest of the public, which includes every individual in the community, is paramount. It is composed of interdependent interests whose just balance necessitates that impartial justice be accorded to every individual.

There is a mutuality of interest among employers, employees, and investors. Their interests as well as the public interest must be defined and protected and to this end public opinion must be kept informed and enlightened.

The first step toward industrial peace will be a realization of the interdependence of all elements related to industry and a recognition of their responsibility one to another.

In government and public service employment the orderly administration of government must be assured, and the paramount interest of the public protected.

Briefly stated, *Justice* to all interests, *Co-operation* between employer and employee, produces *Service* to the public.

### Principles

*1—Employment Relation*—Every person possesses the right to engage in any lawful business or occupation and to enter, individually or collectively, into any lawful contract of employment either as employer or as employee.

*2—The Open Shop*—The right of employer and employee to enter into and to determine the conditions of employment relations with each other (without reference to the affiliation or non-affiliation of either with any organization) is an individual right of free contract possessed by each of the parties.

*3—Right of Association*—All men possess the equal right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men whether of employers, employees, or others, for collective action or dealing, confers no authority over and must not deny any right of those who do not desire to act or deal with them.

*4—Responsibility of Combinations*—The public welfare, the protection of the individual, and sound employment relations equally require all associations or combinations be be subject to the authority of the state. As the public interest is paramount, full publicity of facts of industrial relations is necessary.

*5—Obligation to Secure Production*—To develop, with due regard for the health safety and well-being of the individual, the maximum capacity and output required of industry is the common social obligation of all engaged therein.

*6—Wages and Management*—The wage of labor must be drawn from the product of industry and must therefore be earned and measured by its contribution to production. All employees are entitled to complete business information in matters affecting the terms of their employment; and frankness is essential. In order that the worker, in his own and the general interest may develop his full productive capacity, it is the duty of management to assist him to secure regular employment suited to his abilities, to furnish him with incentive and opportunity for self improvement, and to provide proper safeguards for his health and safety.

*7—Hours of Labor*—The number of hours in the work day or week in which required maximum output, consistent with the well-being of the workers, can be maintained in a given industry should be ascertained by careful study and never should be exceeded except in case of emergency. One day of rest in seven, or its equivalent, should be provided.

*8—Adjustment of Employment Relations*—Adequate means satisfactory both the employer and his employees, and voluntarily agreed to by them, should be provided for mutual discussion and adjustment of employment relations.

*9—Community of Interest*—The greatest measure of reward and well-being for both employer and employee, and the full social value of their service to the public must be sought in the successful conduct and full development of the industrial establishment in which they are associated. Intelligent and practical co-operation based upon a mutual recognition of this community of interest constitutes the true basis of sound industrial relations.

*10—Government Employment*—The state is sovereign and cannot tolerate a divided allegiance on the part of its officers and servants. While the right of government employees, national, state or municipal, to be heard and to secure consideration and just treatment should be amply safeguarded, the community welfare demands that no combination shall be permitted to prevent or impair the operation of government or of any governmental function.

*11—Public Service Employment*—In public service activities the public interest and well-being must be the paramount and controlling consideration. The power of regulation and protection exercised by the state over the corporation should properly extend to the employees in so far as may be necessary to assure the adequate, continuous, and unimpaired operation of public utility service.

## A Statute of Employment Relations Applied to the Construction Industry

### 1.—Employment

(1) The value of a good spirit in an organization is vital to successful industry. The organization may think favorably or unfavorably of its employers, may work with enthusiasm or without any, depending upon what the individual thinks of his employers and the work they are doing. Therefore, there must be frankness between employer and employee, perfect freedom in action and expression of thought, to maintain mutual friendly relations.

(2) When hiring an employee, a complete record of his experience should be obtained. He should be fully informed of the conditions of his employment, wages, hours, location, living conditions, dangers, etc., and the methods of his employer and what he expects of his employee. That is, there should be frankness, mutual confidence, and respect on both sides from the start. Continuous efforts must be made to advance and increase these mutual relations in order to prevent or adjust misunderstandings as soon as they are discovered.

(3) The fact is recognized that in many locations and establishments the basic eight-hour day, or a weekly equivalent, has been adopted as the usual standard. As the number of hours properly constituting a day's work varies in some locations and classes of construction work, it is recommended that changes from the usual standard be so made as not to disrupt or disorganize the rest of the industry.

(4) Overtime work should be discouraged. Where the nature of the work is such as to require employees to work beyond the established hours, they should receive an extra rate of compensation for such overtime.

(5) Continuity of employment is desirable and should be maintained as far as possible.

(6) Apprentices should not be limited in number in any trade. If equitable rules as to the period of service and the degree of skill required of apprentices are made by the various trades, the law of supply and demand will regulate the number.

(7) Discrimination against the use of apprentices by organized labor must not be permitted. Employers in large communities should encourage the establishment of public trade schools and the attendance of the youth at them.

### 2.—Working Conditions

(1) The public interest and the comfort and health of individual employees demand that every effort should be made to perfect the conditions of employment, with special reference to sanitary conditions, heat, light, ventilation; safeguarding the health of workers and providing protection against, and treatment in cases of accidents; suitable rest periods where necessary; and due warning to the worker if he is undertaking to perform a hazardous operation.

(2) Provide safety devices and guards against accident and disease. Mechanical plants, stagings, ways and works should be inspected daily. Where temporary camps are used, provide proper inspection for sanitation, food supply, water, and the welfare of the men.

(3) Employees should be safeguarded against unjust treatment or abitrary discharge by their foremen or immediate superiors. In justice to employees, adequate advance notice should be given, whenever possible, to those who must necessarily be laid off. Likewise, an employee should give reasonable notice to his employer of his intention to leave the service.

(4) The temperament of the gang boss or foreman in direct contact with the hand workers is most important. He must be fair and give his men a square deal.

(5) Establish by conference between the parties what facts concerning the company's and men's activities should be common knowledge to both, and provide for giving these facts fullest publicity.

(6) All states should enact compulsory workmen's compensation insurance laws that are just both to the employer and employed.

### 3.—Production

(1) Public interest requires increasing output per man as a prime factor in reducing construction costs.

(2) Employees should not, therefore, intentionally restrict individual output to create an artificial scarcity of labor as a means of increasing wages or continuity of employment, or of equalizing the productivity and wages of workers having different degrees of skill and ability. Employees should also co-operate with the employer in the adoption of new and improved machinery and methods with a view to increasing efficiency, thereby lowering the cost of construction.

(3) The value of industrial training as a means of increasing production is recognized. Such training should be encouraged by employers and employees.

(4) The reduction in working hours below the economic limit in order to secure greater leisure for the individual should be made only with full understanding and acceptance of the fact that it involves a commensurate loss in the earning power of the workers, a limitation and a shortage of the output of the industry, and an increase in the cost of construction, with all the necessary effect of these things upon the interests of the community and the nation.

(5) As an incentive to greater production, make provision for increasing compensation whereby men of extra skill and knowledge may add to their regular wage.

(6) Make some expression of appreciation, by word or letter, as reward for duty well done.

(7) Make an incentive to extra effort for production in promotion where possible for those who prove worthy.

### 4.—Right of Association

(1) The association in groups of employees not affiliated with an organization of non-employees should be encouraged. The right of employees to organize into trade unions is recognized.

(2) Employees should not require of their employer that employment be conditioned on membership or non-membership in a trades or labor union. Employees should not coerce fellow employees to join, or refrain from joining, a trades or labor union.

(3) Freedom of contract of employment must never be impaired. However, employers should not so exercise this right as to discriminate in the employment or discharge of employees on the ground that they are, or are not, members of a trades or labor union.

(4) Means should be devised to create public sentiment in favor of these principles and to keep the community informed of all action at variance to them.

(5) Capital, employers and employees should be subject to law and its processes with equal facility. Special legislation which may benefit either to the possible injury of the other, or to the possible injury of the consumer, is detrimental—and a consequent menace to the community.

### 5.—Adjustment of Disputes

(1) Adequate means, satisfactory to both employer and employee, and voluntarily agreed to by them, should be provided for mutual discussion and adjustment of employment relations.

(2) Where the channel of communication existing between an employer and the individual employee does not offer employees suitable means of negotiation with their employer, the employer should seek to establish mutually satisfactory means. For this purpose representative negotiation is advocated.

(3) Representative negotiation is defined as that form of collective bargaining which provides for negotiation between an employer and duly accredited representatives of his employees, regarding hours, wages, and all other matters properly affecting their relationship. Employees' representatives should be duly accredited, should be chosen by the employees, from among their own number unless otherwise agreed by employer and employees, and be empowered by the employees to negotiate for them. Such negotiation should be under control of the parties immediately concerned and should they fail to reach an agreement the employer and the group of employees' representatives should each have the option of choosing, without restriction by the other party, a reputable and competent advisor or advocate to meet with them in the continued negotiations. Representatives of employees, selected by and from among their own number, should be assured by their employer that no discrimination will be made against them because of anything said or done in their representative capacity.

(4) As it is often impractical, owing to the nature of the industry, for a single employer to reach a final conclusion with his own employees, a group of employers should negotiate with a group of employees. Such group negotiations should be conducted as far as possible in accordance with the plan of representative negotiations above outlined.

(5) Nothing herein is intended to abrogate the right of an individual employee to negotiate directly with his employer.

(6) Employers and employees should uphold in their integrity all arbitration awards or agreements entered into between them.

(7) While the employer and employee may reach a settlement of their individual relations without reference to outside aid, this solution may affect the rest of the industry, locally, as well as the interest of the public, which is paramount. Therefore, the public's representative ought to have a right of review of a settlement to ensure that its interests

are protected. The interest of the public in reviewing adjustments of industrial relations can be well performed by the establishment of Industrial Courts.

(8) There must be no coercion by either party toward the other. Public sentiment should support all public officials in enforcing the laws in respect to these practices.

(9) The fact should be recognized that both employer and employee are servants of the public, that every disagreement adds to the cost of living and that the final judge in all disputes should be the public. The public should give expression to its views through a board of advisers whose decision should be recognized by both parties as final. Disputes, ill feeling, and discord invariably fade, once the facts are aired and given to the public.

# Minimizing the Risk in Contracting

## —*and the Engineer's Part Therein*

**An Address (Slightly Condensed) Delivered Jan. 25 Before the New Orleans Convention of the Associated General Contractors**

By William B. King
Of the Bar of the Court of Claims, Washington, D. C.

CONTRACTING is far too much gambling and not business, with the cards stacked against the contractor. This fact is partly due to inherent conditions under which the work is done, such as the uncertainties of markets, wages, labor productivity, and weather, but partly to conditions now prevailing, but not necessarily inherent in the work, such as loose methods of estimating and accounting, faulty specifications and vicious forms of contract. This paper is an effort to suggest some aid in eliminating and reducing these gambling elements.

These suggestions must be prefaced by two remarks: First, that the chief elements by which risk can be eliminated are those common to other lines; namely, good judgment in bidding for work and a thoroughly capable organization for executing it; and, second, that these suggestions, derived from long acquaintance and study of the problems of contracting from the outside in litigated cases, are subject to correction by the contractors themselves from their intimate knowledge of the practical side of contracting.

### Basis of Contract

Construction work is commonly carried on under one of three forms of contract, the cost-plus, unit price or lump sum contract.

*Cost Plus*—If the cost-plus contract could generally be adopted the risk in contracting would largely be eliminated. Many of the abuses hereafter discussed find no place under it. Its uses are limited. It was the only possible form for much of the work during the war, but in spite of the fact that it achieved splendid results it fell into popular disfavor.

It changes the fundamental relation of owner and contractor. Under other forms of contract the financial interests of contractor and owner, as to excellence of workmanship and completeness of compliance with the specifications, are opposed; under a proper cost-plus system they agree.

Whether this extremely advantageous method of contracting comes into general use depends largely upon the confidence which individual contractors are able to inspire in the minds of owners, personal or corporate, and upon the recognition by owners that their greatest interest is in having the best building and paying a reasonable price for it

In promoting the cost-plus contract the effort should be in favor of some form of *cost-plus-fixed-fee*, rather than cost-plus-percentage. It will be much easier to establish the former than the latter.

*Unit Price*—The unit-price system tends to eliminate the contractor's risk by paying him upon the basis of the work actually done rather than making him responsible for errors in estimating the work to be done. It is otherwise open to the same abuses as the lump-sum contract and the dangers hereafter pointed out and the remedies suggested are equally pertinent to it.

It is much more applicable to engineering than building contracts. It ought to be used in preference to a lump-sum contract, if cost-plus is not available, in all cases where the work to be done is susceptible of division into prescribed units and where there is any uncertainty about the ultimate plans or the conditions to be encountered. But there should always be a proper variation in the unit prices if the number of units varies materially.

*Lump Sum*—The lump-sum contract in its ordinary form throws upon the contractor not only the legitimate risk, but also the risk of the correctness of his calculation of quantities and of the sound judgment and personal disposition of the architect or engineer. Some of these risks can be eliminated, as will be hereafter discussed.

Every lump-sum contract possesses in the minds of most owners one substantial merit often outweighing all others; namely, that the owner knows in advance what the work is to cost. This will keep the method in general use; so the contractor's interests, therefore, must be carefully safeguarded.

### Quantity Survey

Under present systems of lump-sum contracts the contractor has three branches of work, equally necessary for his financial success. The first is estimating the quantities of material; the second is estimating the cost of placing these materials in the work; the third is the ability to do the work economically and within the estimates.

The estimating of costs and the execution of the work within those costs are uncertain factors. The skill of the contractor finds its opportunity here. His judgment as to markets, his business connections, his judgment as to the future cost and efficiency of labor decide his estimates. His ability to select suitable superintendents and foremen, his elimination of unnecessary overhead and the capacity of his organization for teamwork determine whether he can execute his work within his estimates. These are the legitimate fields for competition, where the most competent man will prove most successful. Variations cannot be eliminated as long as men are of varying degrees of ability.

The estimate of quantities is a different matter; this is purely mathematical. Generally speaking, there can be but one bill of quantities if the plans and specifications are clear and susceptible of but one meaning. The figuring of quantities is really a part of the specifications. It often requires the interpretation of them. A bill of quantities is a definition of the extent of the work required by the specifications. It is the part of the owner to declare to the contractor not only the ultimate structure to be achieved but also the necessary constituents to that result. The contract fixes the conditions of performance of the work, the drawings show the structure to be built, the specifications describe the material to be used and the manner of use, and the bill of quantities, to complete the description of the job, should state the quantities of materials to be used according to the owner's interpretation of the drawings.

In Great Britain it has long been recognized that the bill of quantities is the owner's responsibility. In this country the contractor has assumed this risk. The British practice is sounder in principle.

Beside eliminating the contractor's risk as to quantities the quantity survey presents two other distinct advantages:

a. The efficient contractor has usually built up an adequate estimating department. The more efficient this is the more certain it is to include the entire quantity of every material. The efficient contractor has as a competitor a host of inefficient contractors who have no capable estimating organization. They are far more likely to estimate quantities too low than too high. The inefficient contractor, by reason of estimating quantities too low, bids low, gets the job and loses money on it. His error thus deprives the efficient contractor of an opportunity to do the work to the satisfaction of the owner and at a profit to himself. The adoption of the quantity survey would relieve the efficient and skilful bidder of the fallacious competition of the man who figures quantities too low. The quantities should be figured and guaranteed by the owner and provision made in the contract for an increase or reduction of the contract price for errors in the guaranteed quantities.

b. This practice would save the contractor's overhead. The cost of the estimate on the work not secured either eats up the contractor's profits or is paid by the owner whose work he gets. In any event, someone pays for on the average probably ten times as much estimating of quantities as is necessary. If a quantity survey is made and guaranteed by the owner the cost is of only one estimate and it falls directly where it ought to fall—upon the owner.

### Specifications

This country is deficient in specifications of material and of methods of work. It ought to be possible in the case of almost every material to say that it shall conform to a given grade of fixed and known standards prescribed by a central organization. This would take the place of the old and inexact form: "Unless otherwise prescribed, all material shall be of the best quality."

The contracts of the United States engineering department fix the quality of cement by reference to tests prescribed by certain official publications. Lumber is often specified to conform to the classifications of the lumber manufacturers' associations. The U. S. Bureau of Standards has published some standards of quality. There are standard codes of practice for electric and gas installation. Very fine constructive work has been done by the American Society for Testing Materials. These definitions have generally been of materials and have not included methods of doing work. Like standards and exact definitions should be made of every material used in construction and of every process of installation. The result would be that every contractor would know at once exactly what he was required to furnish and would not be dependent upon interpretation by any engineer or his subordinate.

How loose these specifications have been in the past is illustrated by a case in my own practice in a contract made some years ago by the United States. The specification for framing lumber was in the following terms:

> All framing or other lumber to be thoroughly seasoned, straight-grained and square-edged, free from shakes, wanes, large or loose knots, and other imperfections impairing its durability.

This is supplemented by the following:

> All framing and other lumber, except where specified below, to be bright Southern yellow pine; sap on one edge and extending from this not more than one-third on each face will be admissible.

It is not surprising that the general contractors endeavoring to obtain bids from lumber manufacturers under this specification were advised generally by them that they would not not bid on such vague specifications and were obliged to go back to the United States officer and insist upon his amending the specifications so as to permit the use of lumber in accordance with the carefully detailed classification of the Southern Lumber Manufacturers' Association.

Loose, uncertain and discretionary specifications should be excluded. In a recent contract for paving the streets of a town in Virginia the materials were defined with a moderate degree of accuracy, but the specifications contained the following loose requirement:

> The materials used must comply with the requirements of the specifications and be suitable for use upon the street or street to be paved. They shall be mixed in definite proportions by weight, depending upon their character and the traffic upon the street, and such materials and proportions must be satisfactory to the engineer.

The engineer was quite unfamiliar with street paving and varied his requirements of quantities of the different materials from day to day, finally stationing at the mixer a man who dictated what should be done according to his own daily judgment. Any practical man knows what the result of this must have been upon orderly work at the mixer, upon obtaining the proper materials and having them delivered on time. The specification quoted was a cover for a want of definite knowledge as to what was required.

In the same specifications for street paving the town assumed the responsibility for putting in sewer and water pipes. It relieved itself from any definite obligations by the following provision:

> The town will use all reasonable care and diligence to have sewer, water pipes or other connections and improvements constructed in advance of the laying of the pavement, but will reserve the right to open the street to perform such subsurface work during the progress of the work under this contract which in its judgment it may deem necessary.

No contractor should be obliged to bid on such an indefinite obligation.

In a recent case coming before the courts the specifications provided for a classification of excavation as "either common excavation or rock excavation." These were defined as follows:

> Common excavation shall include all material that can be removed with pick or shovel or by dipper dredge without blasting. Rock excavation shall include boulders exceeding 9 cu.ft. in volume and material requiring blasting for removal.

The contractors came upon sunken logs not expected by either party. These had to be removed by hand and cost the contractors more than twice what they were paid for rock excavation and more than twelve times what they were paid for common excavation. The War Department said that it could find no provision in the contract for paying them anything more than the common excavation price for this unusual condition. Contractors should be protected against such loose specifications as these by expressing in the general conditions that, where unexpected conditions are met, a reasonable allowance shall be made.

This association can render valuable service in co-operating with other organizations to secure more exact definitions of materials and more precise forms of specifications.

### General Conditions of Contract

The American Institute of Architects has prescribed a form of general conditions of contract which is far in advance of any other form in recognizing the contractor's rights as an equal part to a contract. It is not too much to say that every other form in common use is so vague that it is within the power of the architect or engineer to make or break the contractor.

A standard form of general conditions should be framed by engineers and contractors working together and made a part of every engineering contract. It should be carefully prepared upon the principle of doing equal justice to both parties to the contract. There are two primary principles which should control in the preparation of such forms:

a. Proper responsibility should be assumed by each party in his appropriate sphere:

b. All disputed questions should be finally settled through the action of an impartial tribunal.

A form extensively used in contracts with the War Department contained the following provision violative of the first of the above principles:

> It is distinctly understood and agreed that the contractor assumes all risks under and in connection with this contract on account of delays in the work due to any cause.

In another government contract for public buildings the following provision occurred:

> That no claim shall be made or allowed for damages which may arise out of any delay caused by the party of the first part.

The party of the first part was the government and it actually delayed the contractor. The court before which the case came held, as it was obliged to do, that the contractor could recover no damages for delay caused to it by the United States. The injustice of these provisions cannot

be denied, but they occur over and over again in public and private contracts and should be eliminated through the action of an organization like this.

At the present time it is usual to place responsibility upon the contractor for underground or underwater conditions. The owner makes some explorations and places these at the disposal of the contractor, but guards himself from responsibility by some such clause as this:

> The material to be excavated, as far as known, is shown by borings plotted on the drawings herewith (Sheets Nos. 11, 18 and 25), but bidders must inform and satisfy themselves as to the nature of the material. The United States will not guarantee the accuracy of its information.

Usually no time is left for the contractor to make explorations. If there were the cost would be prohibitive. Conditions are found very different from those represented by the borings and the contractor suffers a loss. The courts will give no relief save under exceptional conditions because, they say, the contractor had accepted the responsibility in signing the contract. It is entirely wrong to throw the risk for underground conditions upon the contractor. The site is the owner's and he should assume responsibility. He should make sufficient preliminary surveys through borings or otherwise to satisfy himself of the true conditions and these should be described and guaranteed by him. Thus the minds of the owner and contractor would meet upon a definite work to be done. If other conditions are found upon excavation the compensation should be increased or reduced.

### The Engineer's Decision

The contracts generally in use make the architect or engineer the final authority upon all questions arising under building and engineering contracts. The following is a provision from a government contract:

> These specifications are intended to be full, clear and complete. Any doubt as to their meaning or any obscurity in the wording of them will be explained by the Engineer Officer, who shall also have the right to correct any errors or omissions in them whenever such errors or omissions become apparent. His decision in all such cases and upon all matters relating to the work shall be final and binding upon the contractor.

This is frequently justified on the ground that he is the author of the specifications and therefore the person best able to construe them. This very fact affords the best of reasons why he should not construe them. The engineer writes what in his judgment has a certain meaning; the contractor reads them with another meaning. The proper person to decide what the specifications mean is someone who is acquainted with the general subject-matter but whose mind is not already made up as to the meaning. The question for decision is not the intention of the author of the specifications when he wrote them; it is the intention properly conveyed by the expression used. There should in every instance be an independent tribunal created by the contract from which an appeal could be taken from every decision of the architect or engineer.

The standard documents of the American Institute of Architects, by way of contrast to the above, thus define the architect's rights:

> The architect shall have general supervision and direction of the work. He is the agent of the owner only to the extent provided in the contract documents and when in special instances he is authorized by the owner so to act, and in such instances he shall, upon request, show the contractor written authority.
>
> As the architect is, in the first instance, the interpreter of the conditions of the contract and the judge of its performance, he shall side neither with the owner nor with the contractor, but shall use his powers under the contract to enforce its faithful performance by both.
>
> The architect shall, within a reasonable time, make decisions on all claims of the owner or contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.
>
> The architect's decisions, in matters relating to artistic effect, shall be final, if within the terms of the contract documents.
>
> Except as above or as otherwise expressly provided in these general conditions or in the specifications all the architect's decisions are subject to arbitration.

The easy devolution of authority to the architect or engineer to decide all uncertainties directly encourages vagueness in writing specifications. If the engineer knew that the meaning of his specifications is to be determined not by himself but by independent authority, he would take every possible care to write the specifications with exactness.

Where the right to make final decisions is conferred by the contract upon the architect or engineers, and he decides erroneously, it is held by the courts that no correction can be made, even if he is wrong, no matter how much injustice may result.

This association has already done much preliminary work in exposing the wrongs of the present forms of contract and in pointing out the changes needed. The form of lump-sum building contract in the *Bulletin* for January, founded on the standard documents of the American Institute of Architects, forms an excellent basis of discussion. The committee on contracts may well continue its work by securing the co-operation of other organizations, such as the engineering societies, railroad and municipal engineers, owners of office buildings and realtors' organizations in the adoption of a just form of contract to be adopted for general use

### Uniform Cost Keeping

Another method of eliminating risk arises in the adoption of proper systems of cost keeping. Here again is an instance where the skillful and efficient contractor is at a disadvantage in obtaining contracts. The inexperienced man underestimates his costs and his quantities, and thus underbids the efficient contractor and in the end loses money. Generally he has no proper acquaintance with overhead. The job is lost to the efficient contractor through this unnecessary competition with a possible profit at a reasonable price. Thus both are losers, while the owner, who has been struggling with a losing contractor, is equally dissatisfied.

I recall hearing a distinguished architect say that he considered one of his first duties to an owner was to see that he paid a sufficient price for his work, meaning that this is the only method in which a good job could be insured. An opportunity for extremely valuable work by this association is presented by instructing their inexperienced competitors as to the meaning of overhead and by agitating for a uniform cost-keeping system, whereby it would be certain that every contractor had considered all the elements of cost before making his bid.

A manufacturer doing a large business in a common building material in a middle western city told me that he had found it to his advantage to publish a pamphlet containing his entire cost system and to employ capable men to go about among his competitors and explain to them the advantages of cost keeping on this basis. This subject is ably treated in an article by J. L. Jacobs, the well-known cost accountant, in the Bulletin of this association for June, 1920, and he not only concludes that uniform cost accounting is practicable but he says: "As a result not only are unintelligent competition and unprofitable undertakings largely eliminated, but a closer co-operation and more friendly competition is created throughout the entire industry."

### Conclusion

The result of eliminating the risk as far as possible from construction work is not alone for the benefit of the contractor. Whatever unnecessary risk the contractor assumes must ultimately be included in the cost which the owner pays. There is no other paymaster but the owner. Contractors cannot live without charging a percentage, payable by the owner, to cover unnecessary risk. This becomes a part of the ultimate actual cost. By such risks owners would be relieved of such additional charges and would obtain rock-bottom prices based upon actual work and a complete understanding of the work to be done. Besides this competition would be increased. Yet the contractors would be greatly benefited because the ever-present fear of loss would be measurably reduced.

No contractors' organization in this country has ever been placed upon a sufficiently firm basis to permit it to undertake these movements for the benefit of contractors as a whole until the organization of this association along broad lines, with sufficient financial support to insure beneficial results to the entire body of contractors of the United States.

# Snow Removal and Drift Prevention on Highways

## Principles and Practices of Pennsylvania Highway Department Developed During Two Years of Successful Snow Fighting

BY GEORGE H. BIL

Assistan. Commissioner, Pennsylvania Highway Department, Harrisburg, Pa.

SUCCESS in keeping highways clear of snow requires first a comprehensive, quick-acting general maintenance organization which can be turned to the task. Preparedness in respect to equipment and, also, through foreknowledge of when and where action will be required is the second important requisite. Finally there must be perseverance or continuously applied effort. Strictly speaking, preparedness includes organization, but for emphasis the two are set apart.

Primarily highways are kept clean from snow to serve traffic. Traffic need of an open road the year round does not exist on all highways, but there are main routes connecting industrial communities and market centers and traversing productive farm country which are of great economic value as all-season highways. This value is intensified by the failure, during the last two or three years, of the railways to meet traffic demands. These highways should, by drift prevention and snow removal, be kept open in winter as well as in other seasons; in fact this accomplishment should not be at the option of highway officials but should be required, if necessary, by legislative act.

DRAG AND V-PLOW WORK

Snow removal, however, has an economic value of another sort. On certain types of improved highways there is no doubt that keeping the snow off the surface of the road is of inestimable benefit, as it allows much more uniformity in the action of the frost and in the distribution of the traffic over the entire width of the road metal. A good example of this is shown on some of the modern types of roadway. When the snow has been removed and the traffic wears down the center of the roadway to a point, when melting begins, of exposing the road surface, leaving the sides piled high with snow and fully protected, the earth under the pavement in the center thaws sooner than that upon the sides and the result is that the pavement is fractured or is left spotted in such a manner that future traffic will cause serious detriment.

Snow removal, properly considered is not an emergency operation, it is a permanent function of the maintenance department. Organization for snow removal is, therefore, an inherent part of the general organization for maintenance. In Pennsylvania it consists of the district engineers, county superintendents, foremen and laborers, exactly the same organization, which, during the summer months, does the resurfacing, oiling and general repair work. Under preparedness comes first the necessity of properly protecting by snow fences the points upon the highway where past experience has shown drifting is most liable to occur. There are a number of locations in this state where, previous to the erection of a snow fence, it was necessary to remove by hand deep drifts at a great expense and consequent delay to traffic. After these locations were properly protected, the department's motor-driven snow plows or road machines kept the snow clear.

A fair average price for the fence complete in place at the present time is 50c. per foot. The design is similar to the standard used by the large railroad companies, consisting of eight hemlock boards 10 ft. long 6 in. wide and 1 in. thick placed 6 in. apart and framed together with three braces of 2 x 4-in. hemlock, placed 3 ft. apart from the center, to which are bolted 9 in. from their tops 2 x 4-in. supports 6½ ft. long. These supports are bolted to hemlock stakes driven 15 in. into the ground; the stakes are 2 x 3 in. x 2½ ft. Similar

TRACTOR-OPERATED ROAD MACHINE

stakes driven vertically in front of the frame help to hold it fast. There are about 75 ft. b.m. in each 10-ft. section of this fence.

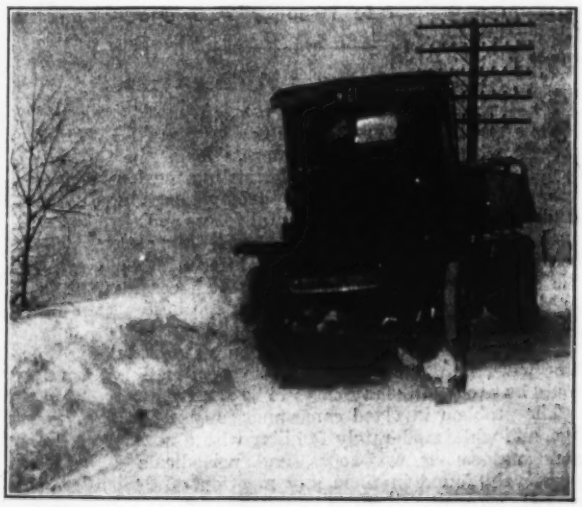
While the snow fence might, in a sense, be considered as equipment, it is assumed that equipment consists of snow plows, motor trucks, drags and road machines. On the first of October, instructions were issued to the several engineers and superintendents to place the different equipment at designated points or sections from where experience has shown they can be most advantageously worked.

Weather forecasts are another preparedness measure. The United States Weather Bureau advises the different superintendents of any severe storms that are expected to sweep over any section of the state. The forewarning gives the organization sufficient time to get into the harness and anticipate the conditions. In further co-operation, the Department furnishes the bureau with a daily statement of the road conditions upon all continuously improved highways. The thought in doing this was that the work thatis being done would not be of benefit to the people unless they were properly advised and had this advice when it was current enough to be of benefit in planning trips.

### Methods and Costs

Fundamentally the method of removal is to start work as soon as the snow begins to fall and keep the snow pushed back off the road as fast as it falls. Methods and equipment are perhaps best explained by a description of the procedure last winter of keeping open for United States motor convoys the 225-mile route across the state from Ohio to Maryland.

The patrolmen who were employed regularly on the highway formed a nucleus to create the larger forces



PLOW ATTACHMENT FOR MOTOR TRUCKS

to handle the work. Each caretaker or patrolman was assigned to a section with instructions to report conditions immediately to the district head or superintendent, who in turn either wired or phoned the main office at Harrisburg. If the conditions were abnormal, the superintendent communicated with the assistant engineer, who arranged an immediate inspection and authorized such steps to be taken as were deemed necessary to expedite the work. The first report of the local

SHOVEL GANGS FOR DEEP DRIFTS

man was followed by a postal card report giving the details and addressed to the central office. This information was charted as soon as received and a bulletin maintained at all times for general information. If the drifts were unusually deep and the road not open within 24 hours, headquarters was advised, which afforded an opportunity to keep in complete control of the entire work at all times.

Work began by breaking a track with road drags and small V-shaped plows drawn by teams. These were followed by road machines or motor trucks, with plow attachments. Turnouts were made at convenient intervals and as soon as possible thereafter the road was widened to between 14 and 18 ft., depending upon the location. The entire travelable width of roadway was finally opened in order that traffic would not cut through to the road surface during periods of freezing and thawing. The snow at first was removed to within 3 in. of the road surface and what did not melt afterward was removed entirely.

These methods apply particularly to improved roads, for if traffic is permitted to track during periods of freezing and thawing on such highways, the surface becomes affected to various degrees, depending on the type of the road. There are a number of miles of waterbound macadam roads with bituminous surface treatments on the main trunk lines and in order to preserve them during such periods it is essential to distribute the traffic. On the unimproved roads the snow is not taken off entirely down to the surface, but several inches are left for the travel to pack, and as it softens, more snow is dragged from the sides, in order to keep the surface comparatively smooth at all times. Rolling of snow is done on the less important lines, but this has not been very satisfactory on the roads where there is much motor traffic, on account of the rough condition that results when the surface becomes cut up. The snow being rolled and wet from time to time with sleet and rainstorms becomes almost as hard as ice. However, there are a number of roads where the travel is light and used mostly by horse-drawn vehicles, where this method will suffice.

There were heavy drifted conditions where special treatment had to be resorted to. These were generally located in cuts where drifts were so deep and banks so high that the snow had to be shoveled and hauled out. As soon as any portion of roadway was open, shovelers followed cutting openings from the edge of the road to the side ditches at various points along the road which

assisted greatly in the protection and drainage of the surface. In addition to this, all side drainage and culverts were kept open and free of obstruction. This precautionary measure produced very good results and when the snow passed away in the spring, the general conditions were better both as to drainage and surface than they had been at any previous time, in spite of the fact that the roads had greater traffic and loads than at any other time in their history.

Snow up to 12 in. in depth can be handled advantageously with road machines and from 12 to 36 in., if not too heavy, can be moved with motor trucks with plow attachments, with excellent results. The truck is run along one side of the highway and back on the opposite side at the rate of about four miles per hour and carries a small crew of men with shovels that are used when the snow piles up in front of the blade which it will do, especially when wet. When there is a greater depth than 3 ft. a large A-shaped plow is used. This implement is 30 in. high at the nose and 6 ft. at the back, with 20 ft. legs, and is 16 ft. wide at the back. It is made of 2½-in. oak plank and 4 x 4-in. framing, held together with movable braces. Drawn by a heavy tractor, it has proved a very economical and effective device. The movable braces are provided for the purpose of permitting vehicles to pass during operation. The light tractors do not hold the road and have been found unsatisfactory for this work. Mechanical devices are preferable in the majority of cases, but if the drifting is a continuous performance in cuts, it resolves itself into a shoveling proposition.

It is impossible to estimate what it will cost to keep different highways open for any winter. During the winter of 1919-1920, which was the most severe in years in this section of the country, the cost ranged from $75 to $350 per mile, while during the year of 1918-1919, the cost ranged from $10 to $30 per mile the entire winter.

## Changes in the World's Shipbuilding

THE following statements, compiled by the U. S. Bureau of Navigation from the quarterly shipbuilding returns of Lloyd's Register, show, says *Commerce Reports*, the merchant ships under construction throughout the world on Sept. 30, 1920, compared with the situation for Sept. 30, 1919.

SEPTEMBER 30, 1920

| Country | Steel Number | Steel Gross | Wood Number | Wood Gross | Total Number | Total Gross |
|---|---|---|---|---|---|---|
| United States | 290 | 1,739,783 | 22 | 32,410 | 312 | 1,772,193 |
| United Kingdom | 955 | 3,728'627 | 6 | 2,471 | 961 | 3,731,098 |
| British Dominions | 61 | 196,208 | 28 | 17,686 | 89 | 213,894 |
| Japan | 72 | 262,407 | ... | ..... | 72 | 262,407 |
| Holland | 165 | 423,400 | ... | ..... | 165 | 423,400 |
| Italy | 67 | 332,713 | 89 | 32,600 | 156 | 365,313 |
| France | 79 | 289,936 | 10 | 2,672 | 89 | 292,608 |
| Sweden | 59 | 118,635 | 10 | 3,214 | 69 | 121,849 |
| Others | 166 | 365,336 | 26 | 17,073 | 192 | 382,409 |
| Total | 1,914 | 7,457,045 | 191 | 108,126 | 2,105 | 7,565,171 |

SEPTEMBER 30, 1919

| | | | | | | |
|---|---|---|---|---|---|---|
| United States | 593 | 3,088,488 | 174 | 382,260 | 767 | 3,470,74 |
| United Kingdom | 752 | 2,802,903 | 29 | 13,870 | 781 | 2,806,773 |
| British Dominions | 76 | 238,649 | 98 | 69,816 | 174 | 308,465 |
| Japan | 64 | 299,600 | ... | ..... | 64 | 209,600 |
| Holland | 113 | 288,042 | ... | ..... | 113 | 288,042 |
| Italy | 59 | 261,328 | 49 | 24,600 | 108 | 285,928 |
| France | 48 | 169,452 | 16 | 5,284 | 64 | 174,736 |
| Sweden | 44 | 94,477 | 20 | 6,740 | 64 | 101,217 |
| Others | 137 | 283,393 | 56 | 19,680 | 193 | 303,073 |
| Total | 1,886 | 7,526,332 | 442 | 522,250 | 2,328 | 8,048,582 |

# LETTERS TO THE EDITOR

*It is the editors' desire to publish here all worthwhile letters pertinent to the interests of engineers and contractors. In order that this may be possible contributors are asked to condense their letters to the shortest space consistent with a clear presentation of their ideas.*

### Am. Soc. C. E. Committee Chairmanships

Sir—There have been appointed recently two very important committees by the board of direction of the American Society of Civil Engineers; the committee on constitutional amendments and the committee on external relations. The chairman of the former committee was elected a member of the society 15 months prior to his appointment to the committee, and the chairman of the latter committee was elected a member 18 months before his appointment.

There can be no objection to the appointment of a small minority of newborn members to any committee; in fact it might be a desirable custom. But why appoint such newcomers to important chairmanships? Are there no members of from five to ten years' membership qualified for these positions, and posssibly more in touch with the society's traditions and aspirations?

Again, why were these chairmen selected from those recently connected with the late construction division of the army?

At least some members of the society would like to know.

Chicago, Dec. 22, 1920. A. T. NORTH, M. Am. Soc. C. E.

[In accordance with the usual practice in such criticisms as this, Mr. Worth's letter was submitted to the recently retired board of direction of the American Society of Civil Engineers, which made the appointments referred to. Under date of Jan. 22 the acting secretary of the society writes: "I am instructed by the board of direction to advise you that no reply will be made by it to your communication."—EDITOR].

### Analysis of Double Footing Pressures

Sir—In *Engineering News-Record* Sept. 9, 1920, p. 494, there appears an interesting article by Marshall G. Findley dealing with the maximum compression on the foundations or joints of piers not capable of resisting tension when these are subjected, in addition to evenly distributed vertical loads, to the moments of horizontal forces acting at angles to each other; such as occurs, for example, if a railway train is being braked when passing over a high bridge pier while at the same time the wind is blowing at a considerable angle to the running direction of the train. It is stated in the paper referred to that the methods in current use applied to the solution of this problem not only give results inconsistent with each other but that the results thus arrived at could be proved in many cases to be far from correct.

The problem involved came under my notice many years ago, and while moderately familiar with a number of American engineering text-books and periodicals I have not previously found in them any mention of the matter concerned; so what follows is restricted to some technical publications available elsewhere.

These are:

(a) A paper by the undersigned in the "Proceedings of the Institute of Civil Engineers (London), Vol. CLXV, Session 1905-6, Part 3."

(b) A paper by Prof. Morike in "Beton & Eisen (Berlin), March 1, 1913, p. 9."

(c) A letter by the undersigned in reference to paper (b)—"Beton & Eisen, Feb. 10, 1913, p. 353." (containing incidentally also an easy method of finding the core of any section).

Prof. Morike finds his results by means of a method of

trial, and an example worked out by him corresponds with what is obtained from my tabulation, while my own demonstration seems to be almost the same as that given by Mr. Findley; at any rate the results obtained from the table practically agree with those worked out by him in the four examples detailed, as will be seen in the following comparison:

| Example | Mr. Findley's Multipliers | Multipliers from My Table |
|---|---|---|
| I | 1.25 | 1.25 |
| II | 3.00 | 2.99 |
| III | 4.29 | 4.30 |
| IV | 13.5 | 13.5 |

(The last figure—13.5—is not in the table, but is obtainable from an item mentioned in the paper.)

A table was worked out in my contribution making it easy to find out the multipliers of the unit compression for any center of pressure (within practical limits) due to the action of horizontal forces on a pier with a rectangular section and enables a result to be established within a few minutes.

Melbourne, Australia, Dec. 4, 1920. F. K. ESLING.

## Concrete T-Beams Designed as Truss

Sir—Recent communications to your journal regarding simple and safe methods of designing reinforced concrete seem to be much to the point. In an effort to arrive at the design of large T-beams by short but rational calculations the writer was led to the method shown in Fig. 1.

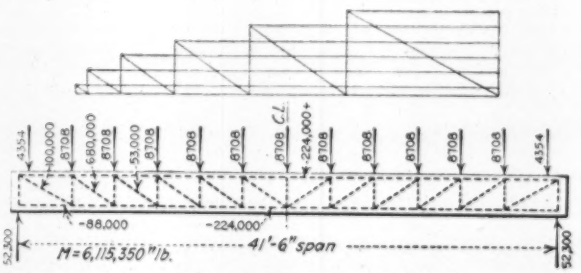



FIG. 1. STRESS DIAGRAM

The values shown in the stress diagram are slightly in excess of the actual stresses. The diagonal stresses in the middle half of the beam can safely be taken by the web.

Beams such as shown in Fig. 2 were designed and successfully built. They carry a dancing and drill floor. A heavy rain washed out the forms the night after these beams were poured, but a level failed to show any deflection the next day. Under full load the deflection was in the neighborhood of ¼ in. No cracks have shown in five years that are discernible to the unaided eye. The beams were built with a camber of ¼ in.

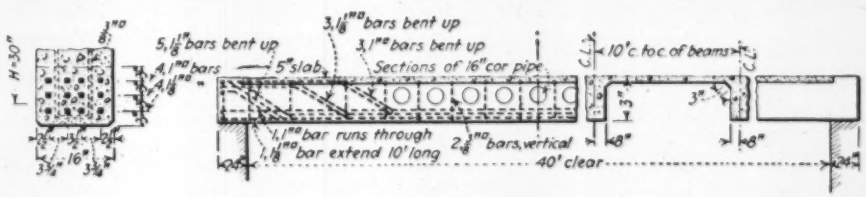



FIG. 2. BEAM DESIGN

It is recognized that the truss analysis does not apply rigidly to the beam. However, there are a large number of variables in such a beam, and also in any solution for same. The concrete itself may easily vary 5 per cent from its assumed value—or may vary that much in different beams. The load will never be exactly as assumed in the calculations, and, we have taken care of the variable effect of vibration by our "factor of doubt" (factor of safety).

We have also to consider that where a *simple* (approximate) method is used we may require a small additional amount of steel, or concrete, as the case may be, and we *save* the *value* of this on the drafting table and in the field. JOHN B. HUTCHINGS, JR.

Asheville, N. C., Dec. 10, 1920.

## The Antioch Plan

Sir—In an article entitled "The Antioch Plan," by Arthur E. Morgan, appearing in *Engineering News-Record* Jan. 20, 1921, p. 108, the statement is made that Antioch, as far as known, was "the first non-sectarian, privately endowed college in the country."

The writer believes that the distinction of having been the first non-sectarian college in the country belongs to Union College, Schenectady, N. Y., Union having been chartered Feb. 25, 1795. The non-sectarian principle was clearly set forth in her charter, a portion of which provided among other things that no ordinance, rule, or order of the institution should ever "exclude any person of any religious denomination whatever from equal liberty and advantage of education, or from any of the degrees, liberties, privileges, benefits or immunities of the said college on account of his particular tenets in religion." The founders of the college also introduced a provision in the charter providing that a majority of the board of trustees should never belong to any one sect.

As to the private endowment, a portion of a recent communication from Dr. George Alexander, president ad interim, Union College, is to the point: "Before her (Union's) charter was granted citizens of three great counties, more than a thousand in number, presented petition after petition *backed by their personal subscriptions* for the founding of a college 'in the town of Schenectady as in every respect the most suitable and commodious site for a seminary of learning in this state, perhaps in America.'"

It may also be of interest to add that in 1845 the department of engineering was established at Union, which was the first engineering course in connection with an American college. EDGAR S. CLOSSON,

Montclair, N. J., Jan. 25. Consulting Engineer.

## State Road Survey Methods and Costs

Sir—I read with much interest the article entitled "State Road Survey Methods and Costs in Missouri," which appeared in *Engineering News-Record* Jan. 13, p. 68, and my attention was particularly directed to the statement of the engineering cost policy. It is the opinion of the writer that there is a misdirected though widespread tendency on the part of engineers and legislative bodies to make a bugbear of engineering locating expense on highway projects.

I believe that highway engineers will in the future have to come to the more expensive and thorough method of projecting a location as is practiced by railroad engineers in all relocations, or at least in country that is difficult and in which construction will necessarily be heavy.

The writer is not aware of the type of country through which the surveys are made in Missouri, but if the country is inclined to be rough, broken or hilly, not to mention mountainous sections, the soundness of a carefully projected location must be apparent to any one who considers the construction cost of the work. As an example let us suppose that a projected location will cost $300 per mile as against a field location cost of $100 a mile. I certainly believe that all locating engineers will agree with me when I state that no matter how careful or experienced the chief of party may be there are many places in a field location that can be improved, particularly in rough country. Even the shifting of the alignment a few feet in either direction on side-hill work materially reduces the cost of earthwork, especially if the material is rock.

Assume, therefore, a projected location to cost $200 more per mile than a field located line. At the present time unit price bids on earth and rock excavation are uncertain, yet we will assume earth at 50c. per cubic yard and rock at 80c. per cubic yard. Using these figures it will only require 400 cu.yd. of earth or 250 cu.yd. of rock to reduce the two methods to equal final cost per mile. I do not believe I shall

be much in error in stating that many hundreds of dollars, and in some cases thousands of dollars, can be saved per mile on construction in broken country by using a carefully selected location, especially at this time when highway costs run from $8,000 to $12,000 per mile.

The means of reduction of first cost might be tabulated as follows: Straightening crooked alignment, shortening total distance, reduction of earthwork, compounding such curves as the topography and tangent lengths will permit, which saves materially in the cost of right-of-way markers, which in this state are constructed of reinforced concrete and are placed at every P.C. and P.T.

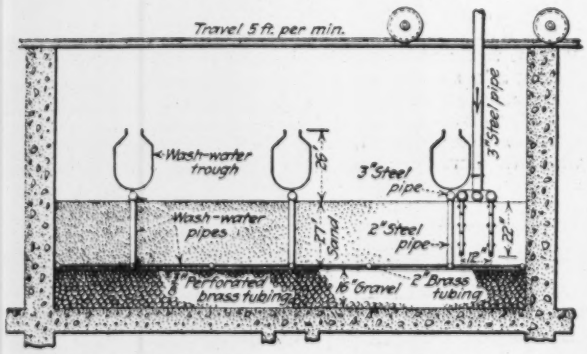
Aside from this reduction of first cost there must be considered the easier grades that result, and the decrease in cost of maintenance on the shortened length, not to speak of the satisfaction of being assured of having the best location possible, which will probably mean something in the future when highway traffic becomes heavy.

I am writing this in the hope that comment will be aroused and some attention directed to this important subject, and through such comment a better understanding of what real engineering economy is.

CHARLES M. NOBLE,
Decatur, Ala., Jan. 23. Alabama Highway Department.

## Proposed Cure for Mud Balls in Filters by Rearrangement of Piping

Sir — On p. 985 of the Nov. 18, 1920, issue of the *Engineering News-Record*, Prof. Charles Gilman Hyde of Berkeley, Cal., suggested that the Blaisdell tractor washer in use at Yuma and Calexico, would prevent the formation of mud balls in mechanical filters, so I have developed the suggestion, as shown in the accompanying drawing, taking the new Toledo filters as a basis for arranging the piping for the use of the washer. It will certainly be a cure for all mud-ball and channeling troubles and the expense of operation will be nominal, for but 3 hp. will be required to give the rakes the reciprocating action. The machine will be electrically operated, the rakes making fifteen 6-in. strokes per minute. The forward motion of the car carrying the rakes will be 5 ft. per minute. An electric hoist will quickly lift the rakes over the troughs.




AUXILIARY MECHANICAL FILTER WASHER TO PREVENT CHANNELING AND MUD BALLS

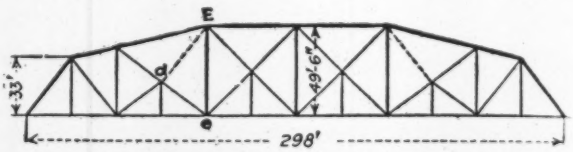
Water pressure for the rake-teeth jets will be taken from a filtered water pressure main, through a flexible hose which will drag behind the machine. The rake washer will be used in combination with the regular work, as often as may be required to keep the filters in first class condition. It will take 10 or 15 min. to wash a filter. One rake will do the work if it is not necessary to wash under the troughs. One washer will have sufficient capacity for almost any number of filters as it can be transferred from one row of filters to another on a transfer table.

A pair of 24-ft. rakes have been used to clean the Calexico municipal filters for five years with satisfactory results.

Los Angeles, Cal., Dec. 30, 1920. H. W. BLAISDELL.

## Resistance to Secondary Stresses Saves Bridge With Member Missing

Sir—The article on "Secondary Stresses in Kenova Bridge" in your issue of Dec. 9, 1920, p. 1116, recalls a somewhat similar structure built in the early days of camelback trusses, about 1888, over the Big Warrior River near Cordova, Ala. At that time but little information was available regarding secondary stresses, and some of the venturesome designers were either overconfident through limited knowledge regarding primary stresses, or repeatedly careless. The structure carried a single track, was designed for a live load of two 171,000-lb. consolidation engines followed by a train load of 3,000 lb. per lin. ft., and weighed about 2,200 lb. per lin. ft. A diagram of the truss is submitted for the use of any readers who may be interested in determining how high secondary stresses may run without collapse.




SUB-HANGER ADDED TO RAILWAY BRIDGE

The structure had been completed and tested, and was in regular service, when the writer discovered that member *dE* should be added, as member *dc* consisted of two plain 5 x 1⅛-in. eyebars only. Considerable pressure was necessary to initiate an investigation because of the confidence in the reputation of the builders, the tests prior to acceptance, and the fact that the bridge was carrying the trains. Adequate haste followed the demonstration of the defect, and a rod 2 in. in diameter was added on the line *dE*.

Subsequent investigation of some other similar spans about 500 ft. long disclosed similar omissions, but all efforts of the writer to locate the responsibility for the blunders were unavailing. Unknown capacity to withstand secondary stresses has saved many structures. The credits and debits should be accurately computed rather than covered by a factor of safety or blanket percentage.

JAMES W. PEARL.
Chicago, Jan. 11.

## Cold Patches with Sand Unsatisfactory in Ohio Road Maintenance

Sir—I wish to take decided exception to that part of an article in your issue of Dec. 16, 1920, p. 1168, entitled "Good and Bad Practice in Making Bituminous Patches," which Mr. Crandell styles, "Cold Patch (Mixed Method)." The Ohio State Highway Department has repeatedly tried sand as an ingredient in its cold-patch work and has never secured good results. We have found that a cold patch made with stone and sand almost invariably waves; whereas a patch made only with crushed stone uniformly gives good results where proper workmanship obtains. We have found that a mix of one part tar cut-back to thirteen or fourteen parts crushed stone (¼ in. to ¾ in.) when mixed by hand, or one part tar cut-back to sixteen or seventeen parts crushed stone when mixed by machine, gives approximately the correct proportion. We have found that, when mixed by hand, if the stone is completely coated after about six turns, the right amount of cut-back has been used.

One of the most valuable lessons we have learned in the use of the cold mix is the economy secured through using a small concrete mixer. We have in many of the counties in Ohio State highway maintenance gangs which are highly skilled in the use of the cold patch and get exceedingly good results in its use on practically all types of pavements.

H. S. PERRY,
Maintenance Engineer,
Columbus, Ohio, Jan. 7. Ohio State Highway Dept.

# NEWS OF THE WEEK

New York, February 3, 1921

## Good Roads Congress Next Week at Chicago

**Program Contains a Dozen Technical Papers and Discussion by Specialists—Equipment Exhibit a Feature**

The program for the eleventh annual Good Roads Congress, to be held at the Coliseum, Chicago, Feb. 9-12, under the auspices of the American Road Builders Association, presents twelve papers on highway topics to be followed by discussion by selected specialists and an announcement of the Good Roads Show, constituting an exposition of road-building machinery and paving materials by manufacturers. The annual banquet is scheduled for the evening of Feb. 10 at the Congress Hotel. The convention will be called to order by President M. J. Faherty at 10 a.m., Feb. 10. The main features of the program follow:

*Feb. 10.*—"Our National Road Problems," Thomas H. MacDonald, chief, U. S. Bureau of Public Roads, Washington, D. C.

"Relation of the Highway and Motor Transport Movement to Education," Prof. C. J. Tilden, national director of highway and highway transport education, Washington, D. C.

"Highway Improvements in New England," A. W. Dean, chief engineer, Division of Highways, Massachusetts Department of Public Works.

"The Local and National Importance of the Lee Highway," Dr. S. M. Johnson, manager Lee Highway Association, Roanoke, Va.

"The Highway's Part in the Development of Efficient Transportation," C. W. Reid, chairman transportation committee, Federal Highway Council, Washington, D. C.

"Subgrades," H. G. Shirley, secretary Federal Highway Council, Washington, D. C.

"Importance of Drainage in Road Construction," F. H. Eno, professor of engineering, Ohio State University.

"Types of Pavements," James H. MacDonald, former state highway commissioner of Connecticut, New Haven, Conn.

"Highway Researches and What the Results Indicate," A. T. Goldbeck, chief division of tests, U. S. Bureau of Public Roads, Washington, D. C.

*Feb. 11.*—"Recent Developments in Road Building," Edward N. Hines, chairman of board, county commissioners, Wayne County, Mich.

"Highway Finance," H. C. Sylvester, vice-president National City Co., N. Y.

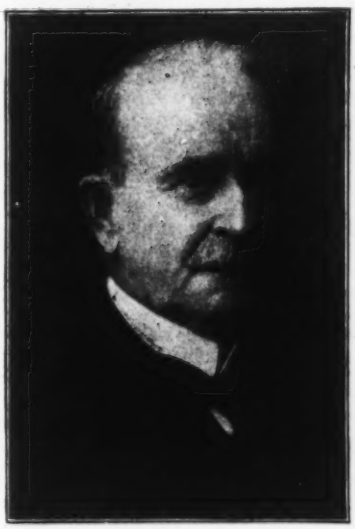
*Feb. 12*—"Relation Between Engineers and Contractors," W. A. Rogers, past-president Associated General Contractors.

## General Contractors in Convention Approve Broad Plans for Association Activity

**Meeting at New Orleans Last Week Indicates Great Progress in Crystallization of Aims and Methods**

Settlement to a definite policy and assurance that the association will be a permanent and ever-increasing factor in the construction industry are the chief accomplishments of the convention of the Associated General Contractors of America which met in New Orleans last week. The convention lacked the dramatic. It listened to some prepared addresses, but its chief work was a quiet appraisal of what was done in the past year and an exchange of views on future policy. This was done more in the corridors than on the convention floor. At the beginning there was question whether the bigness of the plans proposed by the executive board were justified at the present stage of the organization's growth, but this feeling gave way during the meeting to the settled conviction that the plans of the executive board were the right ones. This attitude found expression in the acceptance, without objection, of all the committee reports, in the lack of dissent to the plans proposed for 1921, and in the hearty reception to the newly elected officers, all of them known to favor the program that had been laid before the convention.

*New President of Associated General Contractors*



W. O. WINSTON

At the final session amendments to the constitution were adopted providing for the increase of the number of vice-presidents from three to six, for the appointment of a general manager, and the establishment of the headquarters in Washington. The budget for the coming year, providing for the expenditure of the $119,000 now in sight and the allocation, if realized, of $40,000 more from prospective sources, was laid before the members at this session and approved. The proposal of the finance committee that dues be put on the basis of one-tenth of one per cent of the annual business done by the members was not put before the meeting by the executive board, and the dues for this year will be on the same basis as last. The membership report showed that, as of the end of last year, there were 760 members.

### Past and Prospective Work

Most important was a broad plan prepared under the direction of the general manager, looking not merely to the year ahead but to the desirable work over a period of years. This included, among others, legislative and research divisions. The former would keep in touch with municipal, state and national

*(Continued on p. 238)*

## W. O. Winston Heads Associated General Contractors

W. O. Winston, president of Winston Bros. Co., Minneapolis, who was elected president of the Associated General Contractors at the annual meeting of that organization in New Orleans last week, was born in Hanover County, Va., Feb. 6, 1853, and educated at private schools in Virginia. In 1872 he took up engineering in the service of the Chesapeake & Ohio R.R. Two years later he left the South, going to Minnesota with the United States Government as a member of engineering parties, 1874 and 1875.

He began the contracting business with his brothers, P. B. and F. G. Winston, in the winter of 1875-76, under the firm name of Winston Bros., at Minneapolis, Minn. Their business was incorporated in 1902 as Winston Bros. Co., and Winston-Dear Co. Mr. Winston served as vice-president of Winston Bros. Co. until 1914, since when he has been president. He has also been president of Winston-Dear Co. since its organization.

## Subsitute Road Bill Reported by House Committee

A substitute for the McArthur road bill has been reported favorably by the committee on roads of the House of Representatives. The substitute carries an appropriation of $100,000,000 for federal aid in co-operative highway construction and $3,000,000 for roads and trails in forest reserves. As originally introduced this measure provided for a four-year program, but members of the committee were of the opinion that the incoming administration should be consulted before the program is authorized beyond the next fiscal year. The substitute measure will come up in the House on Feb. 7 under suspension of the rules. No doubt is expressed as to its passage.

The measure may meet with difficulties in the Senate. The bill will be referred to the committee on post offices and post roads, of which Senator Townsend of Michigan is chairman. Senator Townsend has a road bill of his own, but in the face of the nation-wide demand it is believed that the bill will be reported out by the Townsend committee, perhaps with amendments providing for the linking up of interstate roads.

The need for additional legislation, if the federal aid policy is to be pursued, is shown by the fact that no funds are available for new contracts in twelve states. In eight states the funds available would permit of contracts for less than 50 miles of road, while in ten states only enough is available to contract for 120 miles, or less, of new construction. The average annual program is figured as being 200 miles of new roadway.

## Harlem River High Bridge to Remain

Retention of Harlem River High Bridge of the first Croton Aqueduct was decided upon by the Board of Estimate and Apportionment of New York City last week, when the opposing proposals (1) for demolition of the structure and (2) for its reconstruction with a large elliptical arch span to replace three of the present short spans across the river channel came up for final consideration. A full statement of the case was made in *Engineering News-Record* of July 29, 1920, p. 229, in which the plan presented by a joint committee of the American Institute of Consulting Engineers and the American Institute of Architects for constructing a large concrete arch over the river in place of three 80-ft. arches and removing two of the present piers was described and illustrated. The Department of Plants and Structures of New York City favored demolition of the bridge, but the Department of Water Supply desired to retain it as a supplementary water conduit, while residents of Bronx Borough desired the bridge as a future roadway crossing. The estimated cost of demolition was about $500,000, while estimates for constructing the large concrete arch of the joint committee ranged from $900,000 to $1,250,000. An appropriation of $900,000 has been made by the Board of Estimate to carry out this plan.

## Army Engineers Report Against Ocean Ship Canal

In the river and harbor act of 1919 the Chief of Engineers, U. S. Army, was ordered to report on such routes between the Great Lakes and the Hudson River as may be considered practicable by him, with a view to securing a waterway admitting ocean-going vessels to the Great Lakes. In accordance with this order the Secretary of War has submitted as H.R. 890, 66th Congress, 3rd session, the endorsed report of the district engineer of Buffalo, Lt.-Col. Clarke S. Smith, Corps of Engineers, U. S. A. The recommendations in Colonel Smith's report are approved by the division engineer, Colonel J. G. Warren, by the Board of Engineers for Rivers and Harbors, and the Chief of Engineers, Major-General L. H. Beach.

The report calls attention to the fact that this same subject has been investigated a number of times since 1832, when the first report was made. Nevertheless the report details the possible location of such a ship canal, together with the physical status of the present waterways and the business which has been done upon them recently. There are stated all the arguments in favor of and against a canal, leaving aside advantages which may be gained by the concurrent development of water power. At the same time the proposed St. Lawrence waterway is not discussed because it is now being considered by another board of engineers. This leaves three practical locations between Lakes Erie and Ontario, namely the Welland Canal in Canada and two routes through the American Niagara peninsula, one from Tonawanda to Alcott, and the other from La Salle to Lewiston. To get from Ontario to the Hudson River there is the possibility of building a ship channel along the route of the present New York State Barge Canal from Oswego down to the Mohawk Valley and thence to the Hudson, or it might be possible to connect the St. Lawrence River with Lake Champlain, and thence by ship canal to the Hudson.

In the words of the Chief of Engineers the following is the conclusion of the report:

"In reference to the desirability of the proposed canal the district engineer states that this would depend chiefly upon how much of the hundred million tons or more of present through lake commerce would use the new canal or what saving of freight charges, if any, would be effected. It should be borne in mind, however, that the need for economical transportation with the present bulk of commerce of the Lakes is not the only need to be met. The great manufacturing cities of the Lakes now have a tremendous export of import traffic passing through Atlantic ports, chiefly New York. This traffic is now carried by rail and is subject to heavy charges for freight and terminal and transfer costs. As a result of his study of the subject the district engineer reaches the conclusion that it is not advisable for the United States to undertake the construction of a waterway connecting the Great Lakes with the Hudson River at the present time. The division engineer takes a similar view to the district engineer. The Board of Engineers for Rivers and Harbors states that if an adequate waterway were made available with suitable transfer facilities at the principal lake ports, a large amount of general merchandise, mostly grain, might be carried to the seaboard either in ocean-going vessels or in lake vessels transferring at New York. The completion of the New York State Barge Canal has been looked forward to for many years with the belief on the part of many that it would in a measure at least solve the difficulties of transportation and freight rates between the Great Lakes and the seaboard. It has been open for navigation but a short time, too short as yet for business interests to accommodate themselves to it, and it is still too early to determine definitely what its commercial influence will be. It has cost a very large sum and it will be practically all lost if a ship channel were constructed along the same route, even if only between Oswego and deep water in the Hudson. In view of the foregoing and of the investigation of the St. Lawrence River route now being made by the International Joint Commission the board concurs with the district and division engineers in the opinion that it is not advisable at this time for the United States to undertake the construction of a waterway for ocean-going vessels between the Great Lakes and the Hudson River."

Finally Colonel Smith states in his report: "It is my opinion that any improvement in line with the inquiry by Congress is not worthy of consideration at the present time and it is recommended that no such improvement be considered until the actual completion and use of the enlarged Welland Canal and actual demonstration of the adequacy or inadequacy of the New York State Barge Canal indicate a need therefor."

## Start Manitoba Railroad Survey

The surveying for the proposed railway to the Flin Flon copper ore deposits in northern Manitoba has been commenced. Four miles of the line are already built as a spur from Mile 7 on the Hudson Bay Railway. The route lies from this point to Lake Athapapuskow, a distance of 53 miles, thence on the north side of the lake to Flin Flon. The survey is expected to be completed by March 1, 1921.

## N. J. Engineers Urge Road Law Amendments

**Association at Annual Meeting Proposes Many Changes—Traffic Committee Makes Final Report**

Greater extension of traffic census work, involving the planning, now, for the future expansion of the state and the county highway systems, was recommended in a final report which the committee on present and future traffic conditions submitted to the annual meeting of the New Jersey State Association of County Engineers, held at Trenton, Jan. 25. Other features of the program were a discussion of proposed amendments to state road legislation and papers on laboratory control of highway work, bridges for state roads and motor-vehicle registration. F. A. Reimer, engineer of Essex County and vice-president of the association, presided.

While final action in approving proposed amendments to existing laws was deferred a number of suggestions were made and discussed. Opposition developed to the existing requirement for a year's maintenance by the contractor on a completed road. It was felt that any guarantee should cover only workmanship and materials, leaving the matter of maintenance to the individual counties. Such a change, it was contended, would result in better work and lower costs, for a contractor under obligation to maintain a road for a year after completion is sure to include in his bid prices for construction amounts amply sufficient to protect him in this feature of the work.

### Pay for Materials Delivered

The proposal to pay contractors 80 per cent of the value of road-building materials delivered on the site of the work was generally endorsed, but no agreement was reached on the suggestion that a minimum width of 20 ft. for all pavements of materials better than macadam be specified by law.

The need for control of vehicles using county highways was recognized and it was recommended that each county engineer be made an inspector in the state's motor vehicle department. This proposal has the endorsement of Motor Vehicle Commissioner W. L. Dill.

Under existing rates of pay the county engineers have found it difficult to secure competent inspectors and sentiment was unanimous in favor of an increased salary for inspectors, with the provision, also, of inspection of materials at the source of manufacture in addition to the usual inspection of construction. Construction estimates, it was agreed, should not retain from the contractor more than 10 per cent of the value of the work in place. Another recommendation provided for the acceptance of completed work in units of one mile, paying for each unit in full when completed and accepted. Under present conditions the county retains 20 per cent of the value of a completed portion of road.

Greater importance must be attached to the provision of adequate bridges on state and county highways and the proposal to revise existing law so that the state would be required to pay to the counties a minimum of 40 per cent of the cost of bridge construction, instead of 20 as at present, met with general approval.

In the matter of detours it was recommended that the cost of making and maintaining them be included in the cost of road construction, allowing an issue of bonds for the expense of making and maintaining the detours.

Under present legislation counties are required to advertise for all work exceeding in cost $500; it was suggested that this amount be raised to $1,000.

For the protection of work under construction it is desirable to include in new legislation a provision making it a misdemeanor for any one to drive on work which is properly posted and barricaded.

### Laboratory Control

R. B. Gage, chemist in charge of the State Highway Commission's laboratory at Trenton, read a paper on laboratory control of highway contracts. As a means of avoiding delays in construction and preventing the expense caused by the rejection of materials after they have arrived at their destination he endorsed the plan of dividing inspectors into two classes, the first dealing only with construction and the second with materials, the material inspectors to be assigned to the various points of manufacture or production. with powers of acceptance or rejection before shipment.

Charles A. Mead, bridge engineer, New Jersey Highway Commission, in a paper on bridges, made the startling statement that 80 per cent of existing bridges in the state were incapable of meeting the demands of modern traffic. He discussed the various factors entering into the design of bridges of different types and described the New Jersey Commission's practice of using a 20-ton truck as an assumed live load which would produce serviceable bridges. Considerable work is now being done in New Jersey in the reinforcement of old iron and steel trusses by incasing them in concrete and adding reinforcing material.

As a means of protecting New Jersey highways from damage by heavily loaded trucks, W. L. Dill, commissioner of the state motor vehicle department, announced that there are now being installed five road scales, each with a capacity of 50,000 lb., which will be used in checking up the weights of vehicles. The present truck load limit in New Jersey is 30,000 lb. New regulations are contemplated whereby the use of tires "suitable for carrying the loads" will be insisted upon, rather than a specific provision as to width or thickness.

A summary of the committee report on traffic conditions, which concluded the meeting, will be presented in an early issue.

## Licensing Bill in Tennessee

Engineers and architects of Tennessee have agreed upon a joint bill for the registration of architects, engineers and land surveyors in Tennessee. The basis of the proposed bill is the uniform bill proposed by the Engineering Council, modified to suit local conditions.

The Engineering Association of Nashville, Engineers' Club of Memphis, the Nashville, Memphis and Chattanooga Chapters of the A. A. E. and the Tennessee Chapter of the American Institute of Architects co-operated in the drafting of the bill.

A subcommittee with Hunter McDonald representing the Engineers' Clubs, W. P. Butler, representing the A. A. E., George C. Norton representing the A. I. A. and B. H. Klyce as secretary made the final draft and will submit it to the Legislature.

## Garbage Feeding Contract Given Up at Baltimore

The contract for the disposal of the garbage of Baltimore, Md., by feeding to hogs was abandoned by the American Feeeding Co. about the middle of January and the hogs were disposed of without previous notice to the city. The city immediately made a temporary contract with William H. Huse, a farmer of Baltimore County, under which he was to pay the city $45 a scow load for garbage delivered by the city, he to sell the garbage for use as a farm fertilizer. The Commissioners of Baltimore County immediately brought suit for an injunction against that means of garbage disposal on the ground that it would be a nuisance, but before the suit came to trial on its merits the city filed a general demurrer on the grounds of insufficiency.

The history of garbage disposal at Baltimore, together with the various attempts to let a new contract in 1918, the terms of the contract just abandoned, and an outline of the hog-feeding scheme, were presented in *Engineering News-Record* Feb. 6, 1920, p. 287, by Walter E. Lee, who served the city as engineer in its garbage disposal investigations.

In May, 1919, we are informed by Ezra B. Whitman, consulting engineer, Baltimore, Mr. Lee recommended to the incoming mayor that the city build a garbage reduction plant and invite bids for its operation, but no action on this advice was taken. Mr. Whitman also informs us that under the contract with the American Feeding Co. the city agreed to deliver the garbage at specified times and in a fresh condition, but that during severe winter weather in 1919-20 the garbage could not be delivered to the piggery, while in the following summer "the garbage reached the plant in such a putrid condition that it could not be fed to the hogs." As a result of the latter condition, "putrid and excess garbage were used for filling low ground around the plant," giving rise to complaints both as to odors and fly breeding.

## General Contractors Convention

(*Continued from p. 235*)

legislation proposed or in process of enactment, and would study the effect and adequacy of existing laws affecting the contractor. The research division would have a statistical branch to tabulate data on labor, materials and other elements entering into construction. On labor, for example, the data would cover supply, demand, wages, efficiency, co-operative and welfare systems, etc.; on materials, such matters as prices, supply, production, manufacture, transportation, etc.

On the subject of contracts the past year's work included the preparation and publication of drafts of a cost-plus-fixed-sum contract, with and without a penalty and bonus clause, of a lump-sum contract and of a contract for the rental of equipment. Work is under way on a draft of a unit-price contract, while the program for the ensuing year includes study of contracts with sub-contractors, material men and equipment companies. In the work of perfecting the construction contracts the association has been assured the co-operation of other national organizations, including the American Society of Civil Engineers, the American Railway Engineering Association, Engineering Council, the National Association of Builders' Exchanges and the American Association of State Highway officials.

### Quantity Surveys

Joint work during the year resulted in the formulation of a draft of a report on quantity surveying, which has gone to the three co-operating bodies—the American Institute of Architects, Engineering Council and the association—for their consideration. It endorses the quantity survey and urges all engineers, architects and contractors to use their efforts to have facilities established in their communities for making such surveys.

Study of estimating practice has resulted in the development of a standard estimating schedule, which is nearly completed; this schedule is designed, also, to be the basis for a cost-accounting system. A distribution summary sheet, resulting from this work, has already been published. An equipment rental schedule, published recently in *Engineering News-Record*, was prepared. Co-operation is under way with other associations on classification of compensation insurance risks. Though this work is still in the preliminary stage, data already furnished members have resulted in large savings in premiums. The preparation of a *manual* for contractors, containing the standard forms of contract, code of ethics, recommended practice and similar data, was approved by the executive board and by the convention.

The committee on labor prepared a set of "Fundamental Principles of Industrial Employment Relations" (founded on the referendum of the U. S. Chamber of Commerce), and has supplemented it with an elaboration under the title, "A Statute of Employment Relations Applied to the Construction Industry." (See p. 225.)

A tentative code of ethics has been prepared for discussion and criticism.

Legislation received attention in the support by the association of the bill for relief of Navy contractors (following the lines of enacted measures for relief of War Department and Treasury contractors), and in the presentation of facts to the congressional committees on immigration in connection with the Johnson bill. The association co-operated with the Calder committee and has collaborated with other national organizations in furnishing to Congress views of contracting organizations on matters of taxation. It has supported the proposal to organize a national department of public works and worked with the association advocating that proposal.

### Transportation Work

On transportation it has worked with other bodies in securing modifications of the Interstate Commerce Commission orders restricting the use of equipment for moving construction materials and has co-operated in the setting up of special car-service committees to act as an intermediary between shipper and carrier in securing a fair allotment of available cars. The contractors' interests were also represented in rate hearings on construction materials. As a result of these efforts has come a new appreciation on the part of railroad and I. C. C. officials of the vital character of the construction industry.

A Contractors' Service Corporation has been organized to do a brokerage business in contractor surety bonds and to place, when the members desire, compensation insurance. Out of the corporation's 460 shares 450 are owned by the association, the other 10 by members of the association. The profits for the year were $7,000; the sum of $4,500 has been paid to the association in dividends.

Work for the coming year includes logical continuance and extension of the activities cited, and in addition, efforts on standardization of building codes and the formulation of specific procedure affecting general contractors for use in time of national emergency. These proposed elaborations and the new work were put before the members at the beginning of the convention, so as to direct their attention to the year's prospective activities, and each of the items on the program was subsequently gone over and explained.

### Addresses

The set addresses included a lengthy paper by the Comptroller of the Treasury, W. W. Warwick, on the "Interpretation of Specifications," one by William B. King on "Minimizing Risks in Contracting" (see p. 227 of this issue), one by J. Waldo Smith, chief engineer of the New York Board of Water Supply, on "Co-operation of Co-ordinate Organizations of the Construction Industry," and one by Lawrence Mauran, of St. Louis, on "Building Contracts and Specifications."

Judge Warwick's address was chiefly an explanation of the machinery of the comptroller's office. Mr. King's plea was for the elimination of the risks due to indefinite and one-sided contracts, which precipitated a spirited discussion, in which Mr. King's position was heartily supported, though a number of engineer guests pointed out that the arbitrary clauses had been developed as a result of long experience and the necessity felt by the engineer, architect and lawyer for protecting the owner against the unscrupulous and incompetent contractor. Mr. Smith also presented the latter point of view in his paper, but pleaded for toleration and co-operation between engineers' and contractors' organizations to the end that present relations on construction may be improved—to the benefit of the owner, as well as of the engineer and the contractor.

There were papers, also, on various phases of compensation insurance, stressing the great reduction in premiums to the individual contractor through accident prevention methods and propaganda. E. M. Craig, of Chicago, put before the association the accomplishments of the National Board of Jurisdictional Awards in the Building Industry.

### Resolutions

Resolutions adopted at the closing session were to the following effect:

Against discrimination in railroad rates on construction materials; in favor of the Calder bill exempting from income taxation the income on building mortgages; advocating allocation by the Federal Reserve Board of sufficient credits for needed construction; in favor of open markets, without discrimination between purchasers, for construction materials, and against restricting combinations of labor, contractors or material men; in favor of full gathering by the Department of Commerce of statistics regarding source, supply, manufacture and use of building materials; in favor of the national budget bill, of the establishment of a department of public works, and of prompt payments by the Government of its present indebtedness to the railroads; approving the Lockwood Committee investigation at New York and urging full punishment of the guilty in that and in similar situations elsewhere, if they exist; in favor of fair wages, and against taking advantage of unemployment to reduce them radically; urging a study by national, state and municipal officials of the relative efficiency of day labor work versus work by contract; favoring increases in salaries of the technical employees—engineers, architects and draftsmen—of the Federal government; endorsing the National Board of Jurisdictional Awards in the Building Industry and pledging support.

The following officers were elected for the ensuing year: President, W. O. Winston, of Minneapolis; vice-presidents, F. L. Cranford, Brooklyn, N. Y., Arthur Bent, Los Angeles, Daniel Breck, St. Louis, W. E. Wood, Detroit; treasurer, Lee Paschall, Richmond; directors, N. F. Hoggson and W. A. Starrett, of New York, G. O. Muhlfeld, Boston, J. R. Wiggins, Philadelphia, G. C. Mason, Portland, Ore., Richard McCarthy, New Orleans, A. E. Wells, Chicago, Charles Ffolliott, St. Paul.

The holdover officers are: Vice-presidents, J. W. Cowper, Buffalo, L. C. Wason, Boston; directors, H. B. Hanger, Richmond, Ky., E. J. Thomas, Memphis, George Watson, Dallas, M. D. Smith, Detroit. Past presidents D. A. Garber and W. A. Rogers are directors ex officio.

The members of the advisory board for 1921 are: R. B. Porter, Portland, Ore., T. T. Flagler, Atlanta, Thomas Bentley, Toledo, A. P. Greensfelder, St. Louis, Edward Haupt, Chicago, and E. F. Mullen, Cleveland.

## Lumber Production, Shipment and Orders About Half of Normal

According to the recent barometer issued by the Southern Pine Association, the lumber production of 199 mills for December was 54 per cent of normal production, orders for the month were 57 per cent of normal, and shipments were 57 per cent. The stocks on hand Dec. 31 were a little more than twice the stock usually held. Shipments and demands for December were both more than double the production, though the shipments exceeded the demand by a slight margin. Stocks on hand December 31 aggregated 1,341,635,433 ft. b.m.

## Building Congress Organizes Local Branch

The New York branch of the National Building and Construction Congress, organization of which was effected at Atlantic City last August, was established last week, when representatives of the building industry gathered at the Engineering Societies Building, New York City. The local branch is to operate as a part of a national movement to co-ordinate all elements in the building industry in an endeavor to eliminate factional disputes, promote general harmony, and increase the service to the public.

The organization hopes to be an all-inclusive one and the resolution, adoption of which initiated the local movement, includes on its organizing committee to establish a permanent local conference two each of the following: Architects, contractors, subcontractors, labor representatives, materials manufacturers, materials dealers, financiers, engineers, investing builders, and trade press representatives. If any other representatives of the building industry are not included in this list they are to be added as discovered.

The National Building and Construction Congress has as its aims: The thorough study of the relations of the various elements in the industries which enter into building and construction activities; elimination of various factors which have retarded necessary building and construction; a survey of building materials and building labor with a view to economical materials distribution, and establishment of wages which will take into account among other factors the hours lost through seasonal employment; and the study of the causes, with a view to their removal, of the progressive decline in the supply and quality of workers in the industry.

At the organizing meeting Clarence H. Kelsey, vice-president, Title Guaranty & Trust Co., New York City, asserted that there was plenty of money for building construction, but intimated that it would not be available until there had been a considerable recession in materials prices and until labor came to its senses.

The preliminary organization was effected with Robert D. Kohn as temporary chairman, and Sullivan W. Jones as secretary, of the executive board.

## Lockwood Committee Denied Certain Increased Powers

The senate finance committee and the assembly ways and means committee of the New York Legislature on Jan. 25 reported upon the resolution designed to broaden the powers of the Lockwood committee, which recently made an investigation of building conditions in New York City, allowing it to investigate banking concerns in their relation to the building industry. An amended resolution, substituted for the original, gives the committee power to grant immunity though denying it the ability to requisition the records of state banking and state insurance departments. The committee had hoped, through such power now denied them, to show that mortage money could and should be obtained from the corporations who are favored by the state and federal tax laws, in whose hands interest on mortgage loans is exempt from taxation.

## U. S. Chamber Urges Cheaper Building Materials

In the consideration of the housing problem at a two day conference in Washington last week the national council of the United States Chamber of Commerce came to the conclusion that no great revival in construction was possible until there was a considerable reduction in building costs—both materials and labor. Resolutions were therefore passed urging: (1) the continuance of investigations of alleged illegal combinations in the building industry; (2) a study, on the part of each constituent member of the chamber, of the housing situation in its particular community with a view to stimulating a resumption of construction; 3) the performance by material dealers of a full share in meeting the public demand for cheaper building materials; and (4) an investigation by the Chamber of Commerce of the United States of the building industry such as will locate the responsibility for excessive costs. This last resolution sounded the keynote of the situation by declaring that "excessive costs constitutes the greatest single obstacle to a resumption of construction."

Senator William M. Calder, chairman of the Senate committee on reconstruction, warned the conference that unless every practical and economical facility was afforded to the active resumption of construction work the increasing housing shortage might bring about "paternalistic subsidy legislation."

## To Vote on Spring Valley Purchase

A special city election will be held at San Francisco, Cal., on March 8 to vote on a bond issue of $38,000,000 to buy the property of the Spring Valley Water Co.

## Reduction in Labor During 1920 Totals 3,437,466

As a result of a recent survey the employment service of the U. S. Department of Labor estimates that there are 3,473,466 fewer persons employed in industry now than at a corresponding time in 1920, a decrease of 36.9 per cent. This does not mean necessarily that there are that many unemployed, as a large percentage have probably turned to agricultural work. Following is the estimate of discharged men in industry in 15 principal cities: New York, 234,243; Detroit, 160 000; Chicago, 86,000; Cleveland, 81,000; Philadelphia, 70,000; St. Louis, 49 350; Newark, 41,000; Baltimore, 39,565; Boston, 25,000; Milwaukee, 24,330; Cincinnati, 21,000; Kansas City, 20,640; Scranton, 18,000; Jersey City, 15,000; Passaic, 12,000.

The service bases its calculations on "comparative information" from thirty-five states and the District of Columbia and on estimates of unemployment from the thirteen other states.

## San Francisco Settles Building Disputes by Arbitration

Men engaged in the building trades in San Francisco, both employers and employees, have agreed to settle their differences by arbitration. A permanent arbitration agreement was recently signed by the building trades council, representing the workers, and the builders' exchange, representing the employers, and both sides have pledged themselves to be bound by the decisions of the board. The members of the Board are Archbishop E. J. Hanna, Max Sloss, ex-associate justice of the Supreme Court of California, and George L. Bell, consultant in industrial relations and management. All disputes as to hours, wages and working conditions in the building trades are to be referred to the board for final settlement.

# ENGINEERING SOCIETIES

## Calendar

### Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; seventh annual convention, Buffalo, N. Y., May 9, 10 and 11.

AMERICAN CONCRETE INSTITUTE, Detroit; Chicago, Feb. 14-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Houston, Texas, April 27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

AMERICAN ROAD BUILDERS' ASSOCIATION, New York City; Chicago, Feb. 9-12.

**The New England Water Works Association**, at its meeting Feb. 9, will be addressed by Prof. George C. Whipple of the Harvard Engineering School on "The Need for Uniformity in Plumbing Regulations"; G. Wilbur Thompson, "Relations Between Plumbers and Water Works Superintendent"; and Gordon M. Fair, "The Hydraulics of the Flush Valve."

**The American Society for Testing Materials** will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., in the week of June 20. Announcement of the exact date will be made later by the secretary, C. L. Warwick, Engineers' Club, Philadelphia, Pa.

**The Engineers' Club of Baltimore** has reorganized to include the former local branches of the chemical, civil, electrical and mechanical engineers. The officers elected are as follows: President, Ezra B. Whitman, first vice-president, Dr. Frank M. Boyles; second vice-president, Edward B. Passano; treasurer, W. W. Varney.

# PERSONAL NOTES

EDWARD A. WEISMAN, formerly assistant superintendent on steel reinforcing of concrete buildings with the Buffalo, N. Y., branch of the Turner Construction Co., is now junior engineer, Southern Railway Co. at Washington, D. C., compiling reports on changes in and additions to the property of the Southern Ry. system.

JOHN N. CARLISLE, president of the Northern New York Utilities Inc., Watertown, N. Y., has been appointed by Governor Miller a member of the Black River Regulating Board.

RALPH S. HEATH, recently engineer in charge of concrete building construction for the M. J. Roche Construction Co., Cincinati, Ohio, has been employed as resident engineer on Lock 4 at Marseilles, Ill., for the State of Illinois, Department of Public Works and Buildings, Division of Waterways.

MAURICE A. LYNCH has resigned as district engineer at Smethport, Pa., Pennsylvania State Highway Department.

JOHN K. HARRIS has been appointed borough enginer of Sharon, Pa.

H. LEE WILSON, assistant city engineer, Johnstown, Pa., has been appointed city engineer to succeed J. R. Crissey, resigned.

JULIUS ADLER has been appointed deputy chief of the Division of Highways of the Bureau of Highways and Street Cleaning, Philadelphia, Pa.

EDWARD C. GAINES of the Mead Morrison Mfg. Co., Chicago, Ill., is now in Australia in charge of the erection of a large coal-handling plant and other interests of the company at Sydney.

GEORGE W. LEE of North Bay, Canada, acting chairman of the Temiskaming & Northern Ontario Ry. Commission since the resignation of J. L. Englehart, has been appointed chairman of the commission. He was formerly freight agent for the Temiskaming & Northern Ontario Ry. and was appointed a commissioner in 1914.

FRANCIS P. ADAMS, since 1911 city engineer of Chatham, Ont., Canada, with the exception of three years during which time he served in the World War, has been appointed city engineer of Brantford, Ont.

WILLIAM R. ELDEN, for fourteen years sales engineer of the Lidgerwood Mfg. Co., manufacturers of hoisting engines, has joined the organization of Sauerman Bros., Chicago, as engineer in charge of designing and specifying power equipment for Sauerman dragline cableway excavators and Sauerman bottomless power scrapers.

SQUIRE E. FITCH has been appointed division engineer, New York State Commission of Highways, Division 9, with headquarters at Buffalo, N. Y.

A. W. D. HALL, for the past five years city manager of Jackson, Mich., has been appointed city manager of Tampa, Fla.

WILLIAM J. DAVIS, JR., Pacific Coast engineer, General Electric Co., has been transferred to the International General Electric Co. and is en route from San Francisco to South Africa via London to make studies in connection with the proposed electrification of the government railroad between Cape Town and Pietermaritsburg, a distance of about 800 miles. This work is expected to require about a year.

MOTT X. CORCORAN, consulting and designing engineer of reinforced concrete construction, has opened an office in the Merrill Building, Wilwaukee, Wis.

# OBITUARY

DR. WILLIAM T. SEDGWICK, professor of biology and public health at the Massachusetts Institute of Technology, widely known as a sanitarian and civic worker and a past-president of the New England Water Works Association, died in Boston Jan. 26. In next week's issue will be published a detailed sketch of Dr. Sedgwick's professional career.

ALFRED T. TOMLINSON, civil engineer, died at Toronto, Ont., Jan. 21. He was 62 years old. After graduation from the Royal Military College of Canada in 1882 he spent some time in bridge and railroad engineering in Canada. He then engaged for six years chiefly in Nebraska and Colorado on railroad location and construction. In 1891 he became connected with the Brooklyn Elevated Ry. Co., and three years later took charge of the extension of the Lake Street Elevated R.R. at Chicago. Later he became consulting engineer of the Boston (Mass.) Elevated Ry. and had immediate charge of a large part of the construction carried on by that company. In 1902 he joined the staff of J. G. White & Co., New York, and in 1905 he was sent to Montreal as Canadian engineer for that company. During the World War he was in charge of the inspection of small arms ammunition in Dominion arsenals.

JERRY O'SHAUGHNESSY, superintendent of water-works, Columbus, Ohio, died on Jan. 28. With three brief exceptions, due to changes in city administration, Mr. O'Shaughnessy was connected with the Columbus water-works for over fifty years, or since May 9, 1870, as noted in *Engineering News-Record* May 27, 1920.

ALFRED T. WHITE, engineer and philanthropist, was drowned Jan. 29 while skating on Forest Lake in Central Valley, N. Y. He was born in Brooklyn, 1846 and was graduated from Rensselaer Polytechnic Institute in 1865. In 1866 he began a mercantile career in Wall Street. He was interested in the housing conditions for the poor and in 1872 began a study of the housing problem in New York. In 1876 he constructed the first successful tenement houses in this country. In 1890 Harvard University bestowed on him the degree of Master of Arts in recognition of his work for housing reform. He was commissioner of city works, Brooklyn, 1894-1896, and a member of the Tenement House Commission, New York, 1900-1901. He was a founder of the Brooklyn Engineers Club.

ROY BULLEN, whose death was reported in these columns Jan. 13, was a former general agent with the Grand Trunk Ry. at Minneapolis and was not the engineer of the same name located at Logan, Utah, from whose professional record certain facts were erroneously taken.